NATURE

No. 4073 SATURDAY, NOVEMBER 22, 1947 Vol. 160

CONTENTS

	Page
Mass Education and International Understanding	689
A Development Plan for Uganda. By Prof. Walter Fitzgerald	691
Thorpe's Dictionary. By Sir Norman Haworth, F.R.S.	692
Qualitative Quanta. By G. Wyllie	692
British Diving Birds. By Dr. Edward Hindle, F.R.S.	693
A Naturalist's Notes. By Seton Gordon, C.B.E.	693
James Hutton (1726-97) and Sir Charles Lyell (1797-1875). By V. A. Eyles	694
Mechanical Properties of Metals : Conference at Bristol. By Prof. N. F. Mott, F.R.S.	696
Theory and Practice of Dyeing. By H. A. Turner	698
How far can Britain Feed Herself ?	700
Obituary : Prof. J. Masson Gulland, F.R.S. By Prof. J. W. Cook, F.R.S.	702
News and Views	703
Letters to the Editors :	
Origin of Cosmic Ray Stars at Sea-Level.—D. H. Perkins	707
Solar Radio-Frequency Noise Fluctuations and Chromospheric Flares.—Dr. S. E. Williams	708
Photo-electric Fourier Transformer and its Application to Sound-Films.—Dr. D. Brown and J. W. Lyttleton	709
Influence of Water on the Lubrication of Metals.—E. D. Tingle	710
A Silicon–Metal Contact Resistance.—E. H. Putley	710
Vibration Spectra of the Alkali Halides.—Prof. R. S. Krishnan	711
Electron Microscope Investigation of the Action of Salt Solutions on Myosin.—Prof. Silvio Ranzi	712
Plasma-Electron Oscillations.—Dr. E. B. Armstrong	713
Angle of Incidence of the Sun's Rays.—P. J. H. Unna	713
Random Association of Points on a Lattice.—P. V. Krishna Iyer	714
Micro-Estimation of Sugars Separated on the Filter Paper Chromatogram.—J. R. Hawthorne	714
Hydrolysis of Bi^{3+}. Oxygen Bridging—a New Type of Ionic Equilibrium.—Fredrik Granér and Dr. Lars Gunnar Sillén	715
The Electron Affinity of ClO.—Dr. H. A. Skinner ; Dr. Joseph Weiss	716
Physiological Heterogeneity of Metaphosphate in Yeast.—E. Juni, Prof. M. D. Kamen, S. Spiegelman and J. M. Wiame	717
Maintenance of Spermatozoal Motility in Dilute Suspension.—Dr. C. W. Emmens and G. I. M. Swyer	718
Contribution of the Major Constituents to the Refractive Index of Milk.—K. S. Rangappa	719
Determination of Benzene Hexachloride in the Blood of Cattle.—F. Barlow	719
'DD' as a Means of Controlling *Heterodera rostochiensis* (Woll.).—George C. Martin	720
What is a Dialysate ?—Dr. H. G. Derx	720
Science and Technical Education in Germany :	
International Congress for Technical Education. By James T. Kendall	721
Berlin Technical University, 1947. By B. Donovan	722
German Physical Society in the British Zone : Autumn Conference. By Prof. S. Tolansky, F.R.S.	723
Statistical Methods. By Dr. S. Vajda	724
Petroleum Geology. By Dr. W. Rühl	724
Thermionic Emission from Oxide-coated Cathodes. By Dr. F. A. Vick	725
Typhus Research. By Dr. G. Lapage	726
James Hutton : Geologist and Agriculturist	727

Editorial and Publishing Offices
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number : Whitehall 8831
Telegrams : Phusis Lesquare London
Advertisements should be addressed to
T. G. Scott & Son, Ltd., Talbot House, 9 Arundel Street, London, W.C.2
Telephone : Temple Bar 1942
The annual subscription rate is £4 10 0, payable in advance, inland or Abroad

MASS EDUCATION AND INTERNATIONAL UNDERSTANDING

THE discussion on the United Nations Educational, Scientific and Cultural Organisation which took place at the British Association meeting at Dundee attracted a very small audience ; no doubt this was due in part to the fact that the meeting clashed with other important and topical discussions ; but a more important reason is the general lack of knowledge of the activities of the Organisation. Sir John Maud, it is true, headed members of the British co-operating body, and expounded most ably the aims of the Organisation ; he believes it should attempt to instruct the peoples of the world on the realities of the situation, so that they can understand better the causes of peace and war and thus make the politicians' task of direction easier. He sees its task as primarily that of helping people to learn that they need one another, and to deepen their sense of social responsibility, thus pursuing much the line of thought in more general terms that Mr. Henry Stimson follows in his article in *Foreign Affairs* on "The Challenge to Americans". Prof. F. J. M. Stratton dealt with the relations of the Organisation with the international scientific unions, and other speakers in the discussion indicated the wide range of fascinating subjects with which it is already concerned. Its major activities have since been reviewed in a progress report by Dr. W. H. C. Laves, the deputy director, in the *United Nations Weekly Bulletin*. Already some 72 million dollars' worth of material has been collected by voluntary agencies, chiefly in the United States, under the Temporary International Council for Educational Reconstruction, and fifty sets of laboratory equipment have been collected for consignment to forty-one selected laboratories in five countries. Technical needs in the fields of the Press, radio and films have been surveyed in some eight or ten war-devastated countries. It is expected that a conference at Nanking will encourage a pilot project on fundamental education, for which the Organisation will provide an adviser ; and consultant-advisers for pilot projects in the same field are also to be provided for the Governments of Haiti and Nyasaland. The Organisation is also vitally concerned with mobilizing social scientists throughout the world for an inquiry into the tensions affecting international understanding, and a preliminary outline on this study has been distributed to nearly five hundred workers in this field in twenty-nine countries. Preparations are under way for a conference on the social sciences in 1948.

The Organisation also participated in the meetings of the United Nations Sub-Commission on Freedom of Information and of the Press, and has prepared for the Economic and Social Council a study of the shortage and unequal distribution of newsprint and of the bearing of this on the freedom of the Press. Material is being collected through national sources for world lists of films on international understanding, fundamental education, agriculture, health and popularization of science and the arts. An International Scientific Commission called by the Organisation and

the Government of Brazil, which met in Belem in September, discussed the establishment of an Institute of Hylean Research (see *Nature*, Sept. 27, p. 427).

A temporary science co-operation office has been set up in Rio de Janeiro and steps taken to establish an office in the Middle East. A third office, in the Far East, is being established this autumn. Several grants-in-aid have been made to scientific international bodies which are members of the International Council of Scientific Unions. The copyright problem is also being tackled, and assistance has been given in the award of fellowships provided by member States and organisations such as the American Chemical Society for the exchange of qualified personnel.

That the United Nations Educational, Scientific and Cultural Organisation may in such ways as this render great service to science is not to be doubted. The primary ideal on which the Organisation was founded—the free flow of ideas among men—is at the root of scientific advance also. But it should be recognized also that while the Organisation derived much of its original shape and confidence from the intellectuals of Europe, with the new morale among professional men and the clearer understanding of the political power inherent in cultural affairs which the experience of the War gave them, the real leverage of the Organisation in whatever it does must be the power of public opinion; and as Mr. Byron Dexter observes in *Foreign Affairs* (**25**, 388; 1947) the two requirements for the effective application of that force are technical efficiency and unremitting attention to the business in hand.

Dr. Laves' progress report gives promise that the director-general and his staff do, in fact, embody these virtues as they are designed to do, but neither his report nor the discussion at Dundee came to grips with the real issue that confronts the Organisation—the firm rejection by the U.S.S.R. of that primary freedom of information which is an inseparable part of freedom of speech and expression. Mr. Ritchie Calder, it is true, dealt at Dundee with the problem of securing the interest and support of the two thousand million peoples in the world, and maintained that this is only possible through the media of mass communication. The instruments of mass communication, though effective, can be very dangerous; and Mr. Calder estimated that if the Organisation were to have its own newspaper, film-studios and broadcasting stations, it would need an income of a billion dollars a year.

While that would appear to be outside the range of possibility for a considerable time to come, even if it be accepted as necessary or desirable, on the cultural side there are much more hopeful signs than in the political and economic field. The series of international conferences in so many branches of science, and other intellectual activity during the present year, bear witness to a remarkable yearning to override national frontiers, to confer and compare experience. A deep thirst for books and periodicals, for the exchange of dramatic works, films and music is evident to any traveller in Western or Eastern Europe. Mr. Kenneth Lindsay notes in *The Manchester Guardian* that most of those concerned in the rebuilding of European education and culture are anxious to leave political views in abeyance and to resume their specialist studies and scholarship in order to catch up with the last years of research and reading.

Mr. Lindsay points out that besides the old-established international societies reviving their work, there has been a wholly new set of conferences, designed to establish new societies, to build new bridges, and to weave new patterns of thought and culture. His travels have indicated that the vicissitudes of war have given even greater confidence in the values of European civilization and freedom of learning, while shaking the hold of political dogmas. In each country he found the same basic questions being faced: the preservation of standards in secondary schools; the proper approach to youth; the status, pay and freedom of the teacher; the quality of the administrator; the definition and function of a university in the twentieth century; and the supreme importance of adult education and democracy.

Admittedly, education has not kept pace with scientific, political and economic development. Except in one or two areas, the social sciences are backward all over Europe. But while reconstruction work is under way and the British Council, and more recently U.N.E.S.C.O., have repaired some deficiencies by sending technicians and specialists to British universities and Swiss and Swedish technical colleges, Mr. Lindsay pleads eloquently for fresh inspiration and leadership in the universities and among those who form the minds of the growing generation. It is the absence at the present time of European leadership, apart from a small group of thinkers and writers who can only meet each other with considerable difficulty, that Mr. Lindsay regards as the most sinister feature.

Is it possible that the United Nations Educational, Scientific and Cultural Organisation could meet this need, and at the same time boldly take up the challenge represented by Russian rejection of three out of the four freedoms of Franklin Roosevelt? The political and economic organs of the United Nations will not function effectively unless they are matched by the acceptance of some common values—values expressed in general terms which permeate the schools and universities, and above all those million undergraduates in European universities who are destined to influence so largely the next decades of European history. If the Organisation is wise enough to eschew undertakings such as the revision of text-books, which though admirable in theory are likely to prove sterile in practice and merely controversial, and to concentrate on fields such as mass education, the reconstruction of education in Europe, and scientific projects such as the exploration of the resources of the Hylean Amazon, it may do two things. It may secure the widespread support and understanding it needs for success, and doing so it may demonstrate that an edifice built on the four great pillars of freedom of speech and expression, freedom of religion, freedom from fear and freedom from want

is more secure, spacious and satisfying than one based solely on the banishment of want.

There can be no more hopeful way of inducing those who remain outside U.N.E.S.C.O. to use the freedom and the shelter it offers and of thus at last creating one world community; but to succeed in this it is necessary to remember, as Mr. Ritchie Calder has pointed out, that the purpose of the Organisation lies not with the pedants, but with the peoples of the world. It may assist scientific workers, for example, to maintain the unrestricted pursuit of objective truth and the free exchange of ideas and knowledge; but the first duty of the Organisation is not in any such narrow or limited field. It is "to collaborate in the work of advancing mutual knowledge and understanding of peoples, through all means of mass communication"; not merely to increase and improve the means of communication between the thirty-five nations that have accepted the principles defined in the preamble of the Charter, but to use these means for the purpose of mutual understanding, and a true and more perfect knowledge of each others' lives. The measure of achievement of the United Nations Educational, Scientific and Cultural Organisation will depend not merely on the extent to which it enlists the support of men of science and other specialists, but above all on its success in discovering the idioms of the ordinary people and interpreting to them its aims, its plans and its achievements.

A DEVELOPMENT PLAN FOR UGANDA

A Development Plan for Uganda
By E. B. Worthington. Pp. xii+112. (Entebbe: Government Press, 1946.) 2*s*. 6*d*.

IN no part of Britain's tropical empire is research into the available agricultural and commercial possibilities more likely to reward the investment of capital and labour than in the Uganda Protectorate. Focal position within Africa, easily manageable size, reliability of rainfall and—by African standards—a fair degree of soil fertility are among its physical assets; while, in regard to the availability of suitable labour, the intelligence and aptitude of its Bantu and Hamitic communities are well esteemed.

It was inevitable, no doubt, because of the nature of Dr. Worthington's report, based as it is on a comprehensive yet highly summarized statement of the physical resources of the Protectorate, that little space could be spared for mention of the native population upon whose willing, if not enthusiastic, co-operation the project depends. The experience of forced labour for public works is not unknown in East Africa, but it is disappointing that, even before the native response has been tested, the probable need to apply conscription is foretold. A favourable voluntary response from the Baganda, Basoga and other peoples—so very desirable in the interest of the success of the plan, if for no other reason—would largely depend on the moral as well as material incentives which were laid before them. Moreover, the communities of Uganda vary so much between themselves in their traditions and skills that the significance of these factors from the point of view of the plan must be investigated very early. The absence from the report of considerable reference to distinctions between one native community and another suggests the hope that a separate report to include such matters may soon be possible. Estimates of the population (3,956,700 in 1944) show an increase of rather less than two millions since 1911. Here, in the region of the upper Nile, there is no land-hunger comparable with that of Egypt, and it is possible to plan economic development free from pressing anxiety. It is confidently predicted that the population of Uganda will attain ten millions before the end of the century, although the influence of such serious checks on increase as have occurred during the last thirty years should not be under-estimated.

Dr. Worthington's proposals seem to be in harmony with the official view that peasant agriculture must remain the basis of Uganda's economy for a long time to come, even though, in the opinion of the Governor of Uganda, who contributes a foreword, the introduction of European-owned estates and concessions would offer greater prosperity to the Protectorate. The raising of the standard of life can be achieved only by a progressive increase in the productivity of the soil, and the author, offering a warning against a possible dissipation of effort and funds, proposes for the immediate future with which his plan is concerned concentration upon certain experimental projects, known as "pilot schemes", in selected areas. The first of these is to be in South Busoga, at one time known as the "garden of Uganda", along fifty miles of the shore of Lake Victoria between Jinja and Mjanji.

There is a difference in objective between the pilot schemes, as proposed for Uganda, and the well-known groundnut scheme which has been devised for the agricultural betterment of British territories farther to the south in East Africa. The main purpose of the latter scheme, which is intended only for sparsely populated districts, is maximum production of an export crop with the minimum of trouble and with the minimum of native labour, but with a comparatively high proportion of white employees. On the other hand, the pilot schemes of Uganda are intended for the advancement of the standard of life in a comparatively well-populated protectorate, while they both anticipate and encourage the highest density of population which is compatible with efficiency. It is expected that each pilot scheme will involve about £1 million over ten years, with European to African employees in the ratio of about 6 : 6,000.

In its various scientific services Uganda, in common with neighbouring British territories, requires generous expansion; and in meteorology, hydrology, etc., suitable recommendations are made, including the request for the preparation of an atlas of Uganda. For this last-mentioned enterprise the model might well be the "Atlas du Katanga", the first maps of which were published many years ago by the Belgian Government of the Congo.

Tsetse control is perhaps the most urgent of needs, and the widespread invasion of Uganda by fly demands the establishment of a tsetse control department which would plan attacks on the pest from strategic points. The policy of protection, improvement and development of natural resources, with its inevitable emphasis on agriculture, fully justifies the proposed expansion of the Agricultural Department and the foundation of a chair of agriculture at

Makerere College. The expansion of the Uganda Museum is another project of importance to both research and education, and will be concerned both with ethnology along lines already well established and with the evolving life of the native communities.

Every aspect of public service, such as transport and hydro-electric power, receives attention. The scarcity of coal and other fuels necessitates the utilization of the water resources, particularly Lake Victoria, Africa's greatest reservoir. A scheme involving control of the lake-level would provide an ample margin of power, over and above the demand foreseeable within the next ten years.

The maps which accompany the report are well selected, but their uniform scale is too small for the detail of the various distributions shown, and legibility is not always guaranteed.

WALTER FITZGERALD

THORPE'S DICTIONARY

Thorpe's Dictionary of Applied Chemistry

Fourth edition, revised and enlarged. Vol. 8: Meths-Oils, Essential. Pp. viii + 679. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1947.) 80s. net.

THERE can surely be few works of reference which provide so rich a harvest of knowledge as this latest volume, just issued, of Thorpe's "Dictionary of Applied Chemistry". Many of the writers are not only experts in their special fields of interest but are also active workers engaged in the promotion and extension of this knowledge. The impression gained by reading many of the articles written by distinguished authors is that no chemist, whether in the academic or industrial field, can venture far in his subject without having this volume for reference.

The subjects comprised under the titles from "Meths-Oils, Essential" include a mass of general topics of more than ordinary interest in present times. There are also others to which one would go for a fundamental and historical background of subjects of more common interest.

Prof. E. F. Burton of Toronto writes on the electron microscope, Dr. G. B. B. M. Sutherland on infra-red and Raman spectra, and Prof. R. A. Morton on visible and ultra-violet molecular spectra. These articles give a conspectus of present knowledge and of the methods of investigation in these fields. The editors are to be congratulated on having secured, shortly before his death, a valuable article from that veteran, Prof. V. M. Goldschmidt, on geochemistry of minerals. Minerals and X-ray analysis are ably dealt with by Dr. F. A. Bannister of the British Museum (Natural History), and Dr. L. J. Spencer contributes other articles on minerals. Dr. L. E. Sutton, of Oxford, has written on electric dipole moments. Prof. J. R. Partington has contributed the article on nitrogen and the utilization of atmospheric nitrogen, and Prof. J. H. Quastel has dealt with biological nitrogen fixation. Nucleic acids are ably discussed by the late Prof. J. M. Gulland and G. R. Barker, and there is included an article by Dr. C. J. G. Knight on growth factors for micro-organisms, a subject of current interest in view of the manufacture of biosynthetic products.

An authoritative article on octane number is contributed by Mr. F. L. Garton of the Shell Petroleum Co. and another by Dr. J. H. Burgoyne on methane as fuel. Micro-chemistry in most of its aspects is dealt with in great detail, including micro-chemical operations and drop reactions and organic micro-analysis. The major contribution to this volume is that by Dr. E. H. Rodd and his collaborators on naphthalene, which covers this field and provides an important monograph in itself and occupies 176 pages.

Generally the standard of the articles is high and the space allotted to each subject adequate, in some cases amply so for a chemical dictionary. Care has been exercised in the selection of contributors, and in many cases these are men of front rank. Where a large field must be covered in limited space, as in the article on high-vacuum distillation (molecular distillation) by Dr. K. C. D. Hickman of Rochester, N.Y., an exhaustive bibliography accompanies the article. A noteworthy contribution is one on molecular beams by Prof. O. R. Frisch of Cambridge.

The volume is well presented on good paper with sufficient margins and a sturdy binding.

NORMAN HAWORTH

QUALITATIVE QUANTA

The Strange Story of the Quantum

An Account for the General Reader of the Growth of the Ideas underlying our Present Atomic Knowledge. By Banesh Hoffmann. Pp. xi+239. (New York and London: Harper and Brothers, 1947.) 3 dollars.

IT is perhaps ungrateful to begin the review of this delightful book with a complaint, but it is surely unnecessary to state Planck's constant on p. 22 as a pure number. Apart from this, the reviewer must add that no book of popular science since 'Mr. Tompkins'' exploration of the atom has given him such keen pleasure in the reading.

The object of the book is to give for the benefit of the general reader as complete an account of the development of modern quantum theory as is possible without the use of mathematical symbolism. Dr. Hoffmann's general reader, however, must be gifted with an uncommon degree of intelligence and mental agility if he is to derive any clear idea of the developments after 1925 of the theory from a first reading of this book. The author's method of presentation reminds one of a man with a club hewing his way through a hostile mob. The historical development is followed quite accurately, and as each point arises, the probable consequent misconceptions are mustered, presented in their most formidably persuasive form, and then, in the next paragraph, down comes the club. They are knocked on the head and dropped in the gutter, and Dr. Hoffmann advances triumphantly, with the reader, a little breathless and apprehensive, tugged along in his wake. This is showmanship in the grand style, but there is no sacrifice of accuracy in the physics for its sake.

"The Strange Story of the Quantum" succeeds above all in showing that science is no static dry-as-dust body of knowledge. The author's quick-moving style recreates the excitement of the mid-1920's when quantum theory was beginning to assume its modern form. He makes it clear how successive ideas came into contradiction with experience and were replaced, and he emphasizes the precarious state of the present-day physics, with relativity and quantum theory uneasy bedfellows. The pages carry a foam of witty

remarks (some of which are not too easy for the non-American to understand), and it is not the least commendable point of the book that Dr. Hoffmann, perhaps because he is a mathematician rather than a physicist, is not deterred by professional solemnity from making it clear beyond any doubt that 'physics is fun', a truth well known but too rarely expressed.

G. WYLLIE

BRITISH DIVING BIRDS

Haunts of British Divers

By Niall Rankin. Pp. 96 + 83 plates. (London: Wm. Collins, Sons and Co., Ltd., 1947.) 12*s*. 6*d*. net.

THE series of beautiful books which are being issued under the title of "The New Naturalist" receives a most welcome addition in the present volume, devoted to the account of three birds, the great crested grebe, the black-throated diver, and the red-throated diver.

Colonel Rankin, who owns the famous sanctuary on the Isles of Treshnish in the Hebrides, is not only a keen naturalist but also a first-class photographer. The result is a graphic picture of one of England's most attractive water-fowl, and two of Scotland's lesser known birds in the Highlands and Hebrides, accompanied by striking views of the romantic country in which they occur.

The account of the great crested grebe occupies the first half of the book, and is based on observations on a favourite home of these birds, a large tree-fringed lake in Kent, where eight or nine pairs regularly breed and many spend the whole year without migrating. The breeding and nesting habits are described in detail. Special mention should be made of the striking series of photographs showing the feeding of the chicks, and in particular the peculiar habit of each parent of plucking feathers from its own breast and feeding them to its offspring.

The black-throated diver does not breed south of north Perthshire and Argyll, but becomes commoner to the north, although it is not known to nest in the Orkneys and Shetlands. A remote loch in Sutherland provided the material for this study, based on a single pair of these handsome birds. The red-throated diver, a circumpolar species, has a more northerly distribution, and is comparatively common in the Orkneys and Shetlands. The author selected the island of Unst, to the extreme north of the Shetlands, for the study of this species, and also took the opportunity of making observations and illustrations of the sea-birds so abundant in that area. The curious breeding behaviour of the red-throated diver, including the position created when the duty-bird on a nest was approached by three other divers, including the 'other half' belonging to this nest, presents an interesting problem in animal psychology.

The author, in his introduction, modestly states that he offers nothing new to ornithology. Whatever the truth of this statement, he offers the reader the personal observations of a keen observer accompanied by excellent photographs, which constitute a valuable addition to our knowledge of bird behaviour, and will be welcomed by all naturalists.

In addition to the eighty-four photographs by the author, special mention should be made of the coloured frontispiece and eleven pen-and-ink drawings by Margaret Myddelton.

E. HINDLE

A NATURALIST'S NOTES

Highland Naturalist Again

A Gamekeeper's Observations and Discoveries. By Dugald Macintyre. Pp. 220 + 8 plates. (London: Seeley, Service and Co., Ltd., n.d.) 15*s*. net.

DUGALD MACINTYRE, during his long life spent in observing living creatures, has amassed a store of knowledge of the wild life of the Scottish Highlands equalled by few. In this, his latest book, he discourses on seal and hare, ptarmigan and capercaillie, gull and jackdaw, and a host of other creatures. He has a good word to say for the rook, for in spite of its misdeeds in eating grain and potatoes it is the farmer's friend in spring. Let me quote Mr. Macintyre (p. 133): "Billions of leather-jackets, which are the farmer's worst insect enemies, were taken from the fields of young oats and barley and wheat by the foraging rooks. Crops grown near the rookery grew well in bad years for 'grub', when crops too distant for the rooks to reach were destroyed almost to the last blade. There was one big farm many miles from the nearest rookery and rooks were never seen on that farm, so the crops suffered much from grub."

He describes an osprey fishing on Loch Awe in winter. That, surely, must be a very rare occurrence, for the osprey, when it nested in the Highlands, was a summer visitor only, and now that it nests with us no longer it is seen on spring and autumn migration, to and from its haunts in Central Europe.

Were Mr. Macintyre a less competent observer his statement (p. 166) that: "... while the loch [Loch Awe] remained wholly free from frost, but when its shallows were frozen over, the osprey was driven inland, and necessity compelled him to take other food than fish. The gamekeeper found him one day making a meal of a grouse, far inland from the loch: on another snowy day a wild-fowler of Loch Etive saw him pursue and take a wounded widgeon" would be received with at the least grave doubts, for at the season when the Loch Awe shallows freeze the osprey is normally basking in the warmth of the African sun.

On p. 162 Mr. Macintyre mentions that the Scottish capercaillie became extinct about the middle of the eighteenth century, and that the present stock is descended from birds introduced from Sweden. He makes the interesting suggestion that the birds are susceptible to disease, and that for this reason the stocks in certain districts are again decreasing fast.

The felling of great areas of Scots pine during the war years, a felling which still continues, has been injurious to the capercaillie, and the bird is also killed on all land of the Forestry Commission, on account of its habit of destroying the tender leading shoots of conifers. It would be regrettable if the caper were to die out a second time, for it is a noble bird, and adds charm to the dark miles of the old Caledonian Forest, where its cousin, the black grouse, has also become much scarcer during the last score of years.

The publishers of "Highland Naturalist Again" are to be congratulated on the printing of the book, and its excellent paper, in these days of restrictions and difficulties: there are several excellent illustrations, supplied by leading Nature photographers.

SETON GORDON

JAMES HUTTON (1726-97) AND SIR CHARLES LYELL (1797-1875)

By V. A. EYLES

H.M. Geological Survey of Great Britain

THIS year, the hundred and fiftieth anniversary of the death of James Hutton, who has justly been styled the 'father of modern geology', has been made the occasion for a number of commemorative meetings in Scotland, the land of his birth. Addresses have been delivered to the Geological Societies of Edinburgh and Glasgow; and, on November 3, at a special meeting of the Royal Society of Edinburgh, Sir Edward Bailey read a paper on the "Life and Work of Hutton" [see p. 727]. On the same day the Lord Provost of Edinburgh unveiled a memorial tablet in Greyfriars Churchyard. This plaque was appropriately cut from granite, the igneous origin of which was first demonstrated by Hutton; and it was placed close to his hitherto unmarked grave.

It is, of course, especially fitting that such a celebration should have been arranged by the Royal Society of Edinburgh, because the first account of Hutton's famous theory of the earth was read to the members of that Society in 1785, and published in the first volume of the Society's *Transactions* in 1788[1].

Hutton was deeply interested in many branches of knowledge, particularly chemistry and agriculture; but his claim to fame rests on his contributions to the science of geology. These were finally embodied in full in his two-volume "Theory of the Earth with Proofs and Illustrations", published in Edinburgh in 1795. Some further parts of the "Theory", which remained in manuscript form for many years, in the possession of the Geological Society of London, were published by that Society in 1899, as Volume 3 of the "Theory".

Unlike many earlier theories of the earth, such as that of Burnet, and others of the 'physico-theological' school, as it has been termed, a number of which were published in the latter part of the seventeenth and during the eighteenth century, Hutton's theory in its final form was firmly based on deductions made from first-hand observations of the rocks themselves. These he had carried out for many years, often accompanied by friends with whom he discussed his ideas. He also entered into frequent debates, in Edinburgh, with other prominent Scottish men of science, notably Black, the chemist. He read, too, much of the contemporary literature that was relevant to his researches, and this, no doubt, influenced his ideas. Finally, in reaching his conclusions, he was not deterred, as were so many previous writers (and indeed later authors), by the knowledge that his ideas ran counter to the doctrines of the established church.

In spite of the manifest truths, as they now seem to us, that were contained in Hutton's great work, his conclusions met with much opposition, and it was many years before they obtained full recognition. Various causes contributed to this delay. Chief among them was the influence of Werner, whose doctrines, for the most part completely at variance with those of Hutton, were widely accepted at that time and for some years afterwards, not only on the Continent, but in Great Britain also. A contributory cause was that Hutton's style was so obscure and difficult to follow that it may well have prevented some readers from fully apprehending his theories; and, in any event, it seems that his book became so scarce within a few years of his death that it may have been inaccessible to some geologists. Fortunately, a re-statement of the Huttonian doctrines, written in a clear and elegant style, appeared in 1802. This was the "Illustrations of the Huttonian Theory of the Earth", written by Hutton's intimate friend, John Playfair. It was widely read and almost certainly more effective than Hutton's own book in spreading the latter's ideas.

Shortly after Hutton's death, Playfair wrote a biographical account of his friend. Little that is new has since been published about Hutton the man[2]; but during the past hundred and fifty years a number of competent authors have analysed his work[3]. The grain has been sifted from the chaff, and the debt that their science owes to the patient labours of Hutton has been made clear to modern geologists. His contributions to geological thought are now too well-known to need particularizing here.

It is, however, worth recalling that the year of Hutton's death, 1797, is also memorable as the year in which another almost equally distinguished Scottish geologist, Sir Charles Lyell, Bart., was born; particularly because Lyell, probably more than any other, was instrumental in securing the general acceptance, in Great Britain, of the teachings of Hutton. This he did through the medium of his classic, "Principles of Geology", which, first issued in 1830–33, in three volumes, went through twelve editions in the succeeding forty-five years, and was also published in the United States. It was said of Lyell by Sir Andrew Ramsay, "We collect the data and Lyell teaches us to comprehend the meaning of them". Though chiefly distinguished as a critic and writer on the researches of his forerunners and contemporaries, Lyell was no mere armchair geologist and compiler of text-books. He travelled widely both in Britain and abroad, and during his travels widened his ideas, not only by geological field-work, but also by contacts with leading foreign geologists.

When, ultimately, Lyell's matured views were published in the "Principles", he acknowledged his debt to Hutton by inserting at the beginning of Volumes 1 and 2 of the first edition, quotations from Playfair's "Illustrations". In addition, in the historical introduction that occupies the first five chapters of his work, he discusses Hutton's "Theory" against the background of geological ideas that were current when it was published. In spite of this, he was criticized by a contemporary, W. H. Fitton, for not giving due weight in this summary of the history of geology to the importance of Hutton. Writing in the *Edinburgh Review*, in 1839[4], Fitton stated, in reference to Lyell's "Principles", "We think that Mr. Lyell has not, either in his preliminary history or in the body of his works, done quite sufficient justice to the claims of Dr. Hutton—whom we conceive to be effectively the author of the Theory of the Earth now most universally received; . . . This defective appreciation of Hutton we have no doubt may be ascribed, in a great measure, to the direction given by accidental causes to Mr. Lyell's own pursuits; but it is the more unfortunate, as the public and the general reader will naturally make a work so popular as the 'Principles of Geology' their text-book and authority; while many eminent men, engaged in the cultivation of other departments of physical science will be content to take their impression from the clear and fluent pages of that publication; with some indifference, perhaps, as to the

relative merit of those by whom geology has been advanced to its present state."

Lyell received Fitton's review while staying at his father's house at Kinnordy, Angus, and at once replied to the reviewer in a long and interesting letter[5], in which he defends himself from the charge of neglecting to give Hutton his due. The following paragraphs are of particular interest. In referring to Hutton's "Theory", Lyell states: ". . . I found it difficult to read and remember Hutton, and though I tried, I doubt whether I ever fairly read more than half his writings, and skimmed the rest"; and he also records that "The mottos of my first two volumes were especially selected from Playfair's Huttonian Theory, because although I was brought round slowly, against some of my early prejudices, to adopt Playfair's doctrines to the full extent, I was desirous to acknowledge his and Hutton's priority, and I have a letter of Basil Hall's [son of Sir James Hall, intimate friend and supporter of Hutton] in which . . . he comments on the manner in which my very title-page did homage to the Huttonians, and complimented me for thus disavowing all pretensions to be the originator of the theory of the adequacy of modern causes".

In the last part of the letter Lyell writes: "It was my business, in tracing the progress of our science to its present state, to estimate the importance of each writer, and adjust the quantity of space due to him in my historical sketch, not simply according to his originality and genius, but partly at least in proportion to his influence; and I still think that Werner's eloquence, popularity, enthusiasm, and position at Freyberg, placed him in this point of view as much above Hutton as I have represented him to fall below him in reference to the truth of his theories. Yet as an admirer of Hutton all I could have wished is, that your panegyric on Hutton had appeared as aiding and seconding my efforts, since I trust that no book has made the claims of Hutton better known on the Continent of late years than mine".

Lyell is, of course, correct in stating that the influence of Hutton on geological thought during the latter's life-time, and for some years after, was small compared with that of Werner, both in Britain and abroad. By the time the first volume of the "Principles" was published, the influence of the Neptunists, as Werner's followers were called, was definitely on the wane in Britain; but there were still a few 'die-hards' among the more prominent geologists who, though perhaps no longer subscribers to the doctrines of Werner, were yet reluctant to swallow Hutton's teachings in their entirety. Such a one was Adam Sedgwick, professor of geology at Cambridge and president of the Geological Society of London, who attacked Lyell in a presidential address to the latter Society, in 1831, as being, in the "Principles", "the champion of a great leading doctrine of the Huttonian hypothesis"[6]. Lyell's claim, too, that his book influenced continental geologists appears to be well founded. The "Principles" was translated into French and German, and Zittel, in his "History of Geology"[7], states, "In Germany . . . Lyell's works attained immediate celebrity and were made widely known by several translations". In this connexion, however, it should not be overlooked that a French translation of Playfair's "Illustrations" had been published in Paris in 1815[8].

Whether or not Lyell fully appreciated, at the time he wrote the "Principles", the fundamental importance of Hutton's theories, upon which a very large part of the superstructure of modern geology now rests, the judgment of posterity leaves us in no doubt regarding the eminence, not only of Hutton, but also of Lyell himself. Our debt to these two masters has been admirably expressed by Sir Archibald Geikie in his "Founders of Geology": of Hutton he wrote: "The dominant idea in his philosophy is that the present is the key to the past. We have grown so familiar with this idea, it enters so intimately into all our conceptions in regard to geological questions, that we do not readily realize the genius of the man who first grasped it with unerring instinct, and made it the chief cornerstone of modern geology"[9]; and of Lyell he asserted: "But of the English writers of general treatises of geology, the first place must undoubtedly be assigned to Charles Lyell who exercised a profound influence on the geology of his time in all English-speaking countries. Adopting the principles of the Huttonian theory, he developed them until the original enunciator of them was nearly lost sight of. With unwearied industry he marshalled in admirable order all the observations that he could collect in support of the doctrine that the present is the key to the past"[10] . . .

In conclusion, one cannot do better than quote the opinions of the late Sir John Flett; of Hutton's "Theory" he says it was "at once supremely original and perfectly conclusive"[11]; and, referring to Lyell, he states, "By his easy, liquid style, his transparent sincerity, his profound knowledge of the literature and his judicial sense of the value of evidence, Lyell takes the highest place among the expounders of geological science. His work is the greatest and most famous classic in the literature of the subject. To him also we owe the conversion of Charles Darwin, while still a young man, to the orthodox theories of geology. Before Lyell's time scientific geology was already current and widely accepted, though there were still unconverted adherents of the older schools. But Lyell made the subject intelligible to all, so that he who runs may read. Darwin in his journals has recorded the profound impression made on his mind by the first reading of the 'Principles of Geology'. The science had emerged from the mists and obscurity of the cataclysmic school and the Wernerians, and was founded on the sure basis of observation interpreted in the light of the processes operating in the world around us at the present day."[12]

[1] Hutton, J., "Theory of the Earth; or an Investigation of the Laws Observable in the Composition, Dissolution, and Restoration of Land upon the Globe", *Trans. Roy. Soc. Edin.*, **1**, (Pt. ii), 209 (1788).

[2] New information has been collected by Mr. R. J. B. Munro, assistant librarian of the Royal Society of Edinburgh, which, it is hoped, may be incorporated in due course in a Hutton memorial volume that is projected by the Royal Society of Edinburgh.

[3] Notably, Fitton, W. H., "A Review of Mr. Lyell's 'Elements of Geology': with Observations on the Progress of the Huttonian Theory of the Earth", *Edin. Rev.*, **69**, 406 (1839); Geikie, Sir A., "Founders of Geology", 2nd edit., 1905, Chap. 9; Bailey, E. B., and Tait, D., article "Geology" in "Edinburgh's Place in Scientific Progress", 63 (Edinburgh, 1921); Bailey, E. B., in "The Interpretation of Scottish Scenery", *Scot. Geog. Mag.*, **50**, 308 (1934); Macgregor, M., "James Hutton, the Founder of Modern Geology: 1726–97", *Endeavour*, **6**, 109 (1947); Clow, A., and Clow, Nan L., "Dr. James Hutton and the Manufacture of Sal Ammoniac", *Nature*, **159**, 425 (1947).

[4] Fitton, W. H., *loc. cit.*, p. 411.

[5] Lyell, Mrs., "Life, Letters and Journals of Sir Charles Lyell, Bart.", **2**, 47 (1881).

[6] Sedgwick, A., *Proc. Geol. Soc. London*, **1**, 303 (1834).

[7] von Zittel, K. A., "History of Geology and Palæontology", 196 (trans. by M. M. Ogilvie-Gordon, London, 1901).

[8] Playfair, J., "Explication sur la Théorie de la Terre par Hutton" (traduit et accompagné de Notes, par C. A. Basset, 1815).

[9] Geikie, A., *op. cit.*, 299.

[10] Geikie, A., *op. cit.*, 403.

[11] Flett, Sir John, "The First Hundred Years of the Geological Survey of Great Britain", 12 (1937).

[12] Flett, Sir John, *op. cit.*, p. 13.

MECHANICAL PROPERTIES OF METALS

CONFERENCE AT BRISTOL

A SUMMER school and conference on the mechanical properties of metals was held at the University of Bristol during July 2–9. At the summer school (July 2–5) a course of lectures was given by Prof. N. F. Mott, Mr. F. R. N. Nabarro and some of their colleagues on the theory of the subject, especially on dislocations, plastic flow and precipitation. During the conference, papers mainly on experimental topics were given by physicists from various countries, including Meijering (oxidation hardening), Weil (ordered state in alloys), Druyvesteyn (mechanical properties at low temperatures), Andrade, Orowan, Chalmers, Cottrell (creep), Shockley (slip planes in silver halides), Lacombe (crystal boundaries), W. G. Burgers (recovery and recrystallization), Crussard (diffusion studied by thermoelectric methods), Guinier (precipitation), Snoek (elastic after-effects in iron), Guillet (internal friction), McKee and Leadbeater (powders).

Some of this work has already appeared in scientific journals, and many of the papers will be published in a special number of the *Proceedings of the Physical Society*; in this article it seems, therefore, more useful to pick out some salient points from the conference rather than to attempt a report on each paper.

Creep and Plastic Flow

From the experimental side a clear distinction was made by nearly all speakers between 'transient' and 'viscous' creep. Transient creep occurs when a metal, either a single crystal or a polycrystalline specimen, is stressed beyond the elastic limit; after an initial instantaneous extension the rate of strain $\dot{s}$ drops rapidly with increasing time t. Andrade[1] in his pioneering work on the subject gave for polycrystalline metals the formula

$$\dot{s} = \beta t^{1/3},$$

which can be derived from

$$\dot{s} = \text{const}/s^3.$$

In more recent work[2] on cadmium, he suggests for the flow of single crystals

$$\dot{s} = Ae^{ct}.$$

Orowan more recently[3] has put forward the formula

$$\dot{s} = \frac{\text{const}}{s^2} \exp(-\alpha s^3/kT),$$

where the constants depend on the stress and temperature. It is characteristic of transient creep that: (*a*) it is a phenomenon taking place in single crystals or within the grains of polycrystalline materials; (*b*) it always takes place, even at quite low temperatures, following an instantaneous deformation of the material by any stress exceeding the elastic limit.

Viscous creep is the term given to the ultimate steady rate of creep which is obtained in certain cases. The term 'viscous' is slightly misleading, since, of course, the creep-rate is proportional to a high power of the stress. According to Andrade, in the early stages of creep there is rotation of the crystallites, accompanied by glide on crystal planes, but the final stages of true viscous creep in polycrystalline materials take place in a narrow zone surrounding the crystal boundaries, there being no deformation of the crystals as a whole at this stage.

In trying to understand creep, one has first of all fairly clear evidence that slip of one crystal boundary over another can occur and is a truly viscous process, the rate being proportional to the stress. A recent paper[4] from Zener's school in Chicago has used measurements of internal damping and other anelastic effects in pure polycrystalline aluminium to obtain a figure for the rate of slip at the grain boundary in this metal. The result is

$$\text{Rate of slip} = \text{stress} \times 5 \times 10^8 e^{-17,250/T} \text{ cm./sec.}$$

Of course, unless the grain boundary is flat (or of constant radius of curvature), any slip along the boundary will set up elastic strains near the surface of the grains; these strains are probably the cause of intercrystalline failure in creep tests in lead and other metals. Viscous creep possibly has its origin also in this grain boundary slip, which for large values of the applied stress will proceed until deformation takes place in the protuberances of the grain surface which lock the grains together. (This seems to be in accord with the observations of W. A. Wood and H. J. Tapsell[5], who find that a specimen of aluminium extended 0·9 per cent at 300° C. in a creep test shows little deformation of the reflexion spots from the grains; while, after a rapid deformation followed by heat treatment at 300° C. for an equal time, the deformation is much greater. They deduce that in the former case slip is mainly along grain boundaries; in the latter, deformation of the whole crystal occurs.) Since the stresses involved in grain-boundary slip can reach values much greater than the applied stress, one may expect deformation of the boundary region to occur until recovery or recrystallization sets in. The steady creep-rate, then, will be reached when hardening and recovery in the boundary regions just balance each other, and any quantitative theory must await a theory of these processes.

For transient creep, the elements of a theory are beginning to appear, based on the concept of dislocations. In any theory of this type, one has first to ask: Is the resistance to deformation shown by actual materials due to the difficulty of forming dislocations, or to the difficulty in moving them? The obvious fact that hardness increases with all kinds of internal strains and impurities suggests that the latter is the case. The source of dislocations remains something of a mystery; grain boundaries and mosaic boundaries (which can probably be represented as rows of dislocations) are possible sources, and, in slip bands, dislocations which have been set into rapid motion almost certainly generate others. However, for considerations of transient creep, it is probably adequate to consider that enough dislocations exist already.

One then ascribes the resistance to yield of any material to the internal stresses σ_i which exist in a material due to grain boundaries, precipitates or 'stuck dislocations'. These will prevent the motion of dislocations unless the applied stress σ exceeds σ_i. In this, one follows G. I. Taylor's theory of strain hardening[6]; but, as emphasized by the present writer, the deformation of single crystals, which harden rapidly, is theoretically a much more complicated problem than the deformation of hard materials (for example, precipitation-hardened alloys); in a hard material, investigations of creep or deformation will give information about the

motion of dislocations under internal and external stresses which remain constant during the experiment.

According to the theory of Becker and Orowan, the energy of activation required to move a dislocation from one position of equilibrium to another, if the applied stress is σ, is

$$V(\sigma-\sigma_i)^2/2G.$$

Here G is the shear modulus, and V a volume of order $(200\,\text{A.})^3$. Arguments were given by the present writer for replacing this (for precipitation-hardened materials) by

$$U(\sigma_i) = 0{\cdot}1\ \sigma_i a\lambda^2\ \left(1-\frac{\sigma}{\sigma_i}\right)^{3/2}.$$

Here a is the interatomic distance, and λ the distance between centres of stress. The chance $\alpha(\sigma_i)$ that a dislocation moves forwards is then, per unit time,

$$\alpha(\sigma_i) = \nu \exp\{-U(\sigma_i)/kT\}.$$

As Orowan[3] in particular emphasized, in transient creep, when the instantaneous extension is at an end, dislocations will be present in the material in positions for which σ_i has all values from σ upwards. Thus creep is, initially, a process of which the rate is determined by activation energies $U(\sigma_i)$ with all values from zero upwards. As the dislocations in particularly favourable positions, that is, those with small $U(\sigma_i)$, are used up, the creep-rate slows down. If $N(\sigma_i)\,d\sigma_i$ $(\sigma_i \geqslant \sigma)$ is the number of dislocations, at the end of the instantaneous extension, in positions for which σ_i lies in the range $d\sigma_i$, then after time t the number is $N(\sigma_i)\exp\{-\alpha(\sigma_i)t\}d\sigma_i$. The creep-rate is thus proportional to

$$\int_{\sigma}^{\infty} N(\sigma_i) \propto \exp(-\alpha t)d\sigma_i.$$

On the assumption that $N(\sigma_i)$ is constant, this integral has been worked out by the present writer. One obtains an extension-time curve of the type

$$S = \text{const}\,\{\log(\nu t)\}^{2/3},$$

where $\nu \sim 10^9$ sec.$^{-1}$. Such a curve seems to represent transient creep at low temperatures (for example, for lead, Andrade, *loc. cit.*), but certainly does not cover the whole range of phenomena described as transient creep.

An interesting extension of the dislocation theory was given by Cottrell. Cottrell showed that impurities in solid solution would be present in abnormally low or high concentrations in the neighbourhood of a dislocation; he spoke of a "Debye–Hückel atmosphere" of dissolved atoms around a dislocation. This atmosphere, if it is given time to form, will anchor a dislocation in position, introducing a definite local value of σ_i and hence accounting for the existence of a sharp yield point. The explanation was particularly apposite in the case of iron, where the yield point may be taken to depend on the segregation of the easily mobile carbon atoms around the dislocations. Snoek demonstrated to the Conference that the purest iron (less than 0·0001 per cent of carbon by weight) does not have a yield point. It may also be of importance in explaining the considerable observed dependence of yield point on temperature for most metals, on which Druyvesteyn reported to the Conference. It is inherent in the theory of transient creep sketched above that the activation energy $U(\sigma_i)$ is very large in comparison with kT unless σ is within a few per cent of σ_i; therefore, the dependence of yield stress on temperature cannot exceed a few per cent unless the internal stress σ_i is itself temperature-dependent. Cottrell's assumption of an atmosphere of dissolved atoms in equilibrium around the dislocation will obviously lead to a decreasing resistance to yield as the temperature rises and the atmosphere is driven away. The theory also gives an elegant explanation of the phenomenon of micro-creep observed by Chalmers[7] in tin, where the creep-rate for small stresses is proportional to stress; in this process dislocations move, carrying their atmosphere of impurity atoms with them.

Internal Friction

Snoek[8] reported on his work on the elastic after-effect in iron; he showed that damping of vibrations in iron is partly due to the dissolved carbon atoms which set up local stresses, and which, in jumping from one equilibrium position to another, absorb energy from the vibrations. Other work on internal friction, this time on gold-copper alloys, was reported on by Guillet, who pointed out the very low damping of the alloy Cu-Au after quenching; in this quenched alloy, presumably very small tetragonal domains are found.

One can now distinguish the following mechanisms which account for internal friction: (*a*) thermal currents between crystals of a polycrystalline material, or between strained regions of one crystal[9]; (*b*) slip along crystal boundaries, producing elastic strains in the adjoining material[4]; (*c*) presence of mobile dissolved atoms producing a tetragonal strain (for example, carbon in iron, as described above); (*d*) presence of mobile dislocations; internal friction of this kind is much reduced by annealing (recovery), and increased by quite small amounts of cold work[10].

The cause of absorption of energy from vibrations of small amplitude is not the motion of a dislocation from one position of equilibrium to another, but its vibrations about one position of equilibrium. The amplitude of vibration (and hence the damping) should for low frequencies be proportional to $\lambda^2(\sigma/\sigma_i)^2$, where λ is the distance between the centres of strain. Thus increasing hardness (increasing σ_i) gives low damping, as does also small values of λ. The small distance between the stressed tetragonal domains in the quenched Cu-Au alloy is likely to be the cause of the abnormally low damping.

W. G. Burgers[11] discussed recovery and recrystallization, and emphasized the difference between them. Recovery seems to be connected with the motion of dislocations, which move under each other's attraction or repulsion. In recovery, individual crystals retain their identity, and lose only part of their work hardening. In recrystallization, on the other hand, new crystals, having fully the properties of the annealed material, are formed and eat up the cold-worked material by a process at present little understood, but not so obviously connected with the motion of dislocations.

Diffusion and Precipitation

Meijering discussed the oxidation of silver containing aluminium in solid solution. Oxygen dissolves readily in silver, but the binding energy is small. The binding energy of aluminium and oxygen is large, and oxygen atoms diffusing in from the surface are trapped when they encounter aluminium atoms. A sharp boundary is formed between the interior of the specimen, which contains aluminium atoms in solid solution, and the exterior, which contains single

molecules of aluminium oxide. These molecules are too large to diffuse through the lattice, and their binding energies are so high that they are unable to dissociate and diffuse as single atoms. Oxidation hardens the alloy, and the normal effects of over-ageing, leading to softening and the formation of microscopic particles of precipitate, are suppressed.

An X-ray analysis of more usual types of precipitation was reported by Guinier. His results, parts of which have already been published[12], are obtained by the use of a single-crystal specimen and monochromatic radiation. In aluminium-copper alloys, where the solute atoms differ in size from those of the solute, the initial nuclei of precipitation are plates one or two atoms thick and about 25 A. in diameter. From absolute intensity measurements he finds that about a fifth of all the copper atoms form such plates, the remainder staying in solid solution. The initial nuclei are about 90 A. apart. In the aluminium-silver alloys, where all atoms are of nearly the same size, the initial nuclei are roughly spherical, and may be considered as sinusoidal fluctuations in the concentration of silver atoms with a wave-length of about 70 A.

N. F. MOTT

[1] Andrade, *Proc. Roy. Soc.*, A, **84**, 1 (1911); **90**, 329 (1916). Andrade and Chalmers, *Proc. Roy. Soc.*, A, **138**, 348 (1932).
[2] Andrade and Roscoe, *Proc. Phys. Soc.*, **49**, 152 (1937).
[3] Orowan, *J. West Scotland Iron and Steel Inst.* (in the press).
[4] T'ing-Sui-Ke, *Phys. Rev.*, **71**, 533 (1947).
[5] Wood and Tapsell, *Nature*, **158**, 415 (1946).
[6] Taylor, *Proc. Roy. Soc.*, A, **145**, 362 (1934).
[7] Chalmers, *Proc. Roy. Soc.*, A, **156**, 427 (1936).
[8] Snoek, *Physica*, **8**, 711 (1941).
[9] Zener, *Proc. Phys. Soc.*, **52**, 152 (1940).
[10] Read, *Amer. Inst. Mining and Met. Eng., Tech. Pub.* 1309 (1941).
[11] Burgers, *Proc. K. Nederl. Akad. van Wet.*, **50**, 452 and 595 (1947).
[12] Guinier, *J. Phys. Radium*, **3**, 124 (1942).

THEORY AND PRACTICE OF DYEING

THE symposium held by the Society of Dyers and Colourists at Blackpool during September 25–27, to discuss recent advances in textile coloration, may prove to be of great importance, not only in the annals of the Society itself, but also in the modern history of the subject. The interests of the Society have always ranged very widely, including, at one end of the scale, the industrial production of tinctorial materials and processed fabrics, and, at the other, fundamental studies of textile fibre properties and the chemical and physical processes underlying the operations of dyeing, printing, finishing, etc. Increasingly in recent times, due principally to the growth in the physical sciences, and the narrowing specialization thereby encouraged, it has become difficult for workers situated at these antipodes to know about and to appreciate the significance of each other's work. This symposium marked a *rapprochement* perhaps more significant and more far-reaching than could properly be conveyed by the most careful and accurate summary of the material in the papers read and in the discussions which ensued.

The programme was almost as variegated as the interests of the members. A group of papers contributed by Dr. T. Vickerstaff and his colleagues of Imperial Chemical Industries, Ltd., by Mr. J. Crank of Courtaulds, Ltd., and by Dr. S. M. Neale and Mr. J. M. Preston of the Manchester College of Technology, attempted to define quantitatively the intimate mechanisms of dyeing processes in terms of the energy changes occurring during the processes, or by reference to the active chemical groupings and fine structure of the fibres. What may be called without disparagement the empirical technical side included an informative and well-arranged review of American and German dyeing methods by Dr. R. G. Fargher of the Shirley Institute, a discussion of automatic temperature control in dyeing machines, analytical methods for the identification and assaying of dyes, technical advances in the dyeing of acetate rayons, etc. The latter, the technical, group of papers had, of course, the wider appeal and the more general intelligibility, and they were discussed at length from all parts of the meeting. The first group, however, might fairly be said to have shown itself to be of the greater significance for future development and to have presented the most interesting, and, in the discussions that followed, the most amusing impression to the general observer.

The papers in this group were couched largely in the language and symbolism of physical chemistry, and, in spite of very ingenious interpretative efforts on the part of the protagonists, especially Dr. Neale, their direct and ultimately weighty influence on industrial procedure could not be fully appreciated by many of those whose daily concern is the bulk-production of finished textiles for a competitive market. This situation did not, as it might have done, result in a wider cleavage, but led rather to attempts to define the function of the technologist as the agent for bringing about a liaison between the two sides, and a call for the increased intake of young trained scientific workers into the textile industries. This point of view was put very forcefully and cogently in the discussions by Mr. R. J. Hannay, himself a chemist and calico printer of wide experience and consistently progressive attitude. What may be regarded in some degree as an admonition to both sides came from Dr. E. B. Abbot of I.C.I., who reviewed many of the recent advances in our knowledge of dyeing mechanisms, and attempted to show the extent to which this knowledge has been, or could be, made applicable in the conduct of full-scale processing operations. One most important statement is best given in Dr. Abbot's own words. "A criticism frequently levelled at research workers by technologists is that they are too far removed from realities. In the case of the direct dyes on cellulose, however, we feel that much of the research work has, on the contrary, been too closely related to narrow practical aims, and has consequently lacked that breadth of speculative perception by which primary truths are revealed. We believe the type of research carried out by Neale and his co-workers on direct dyes and cellulose to be more correctly motivated, but an extension of this work, particularly towards a wider examination of different dyes, is required." For this report to do justice, it must be said that, in the discussion, a very strong attempt was made to justify what may be called the interim type of investigation, in which technical behaviour of a range of dyes is defined quantitatively and working rules are enunciated without immediate reference to ultimate causes. In long-established industrial processes such as dyeing, where superficially simple operations exploit a very complicated interplay of variables, these interim investigations often represent the only practicable first assault on the technical problems that need to be solved. There is a danger in this type of investigation that the volume of data

which may accumulate from the use of comparatively simple experimental methods may obscure the limits of its value and may lead to premature complacency.

An attempt may now be made to deal in greater detail with the contents of the more fundamental papers. Following the general line of progress in dyeing theory, it may be said that these papers again emphasized the greater ease and certainty of the theoretical treatment of the dyeing process for basic fibres as compared with cellulose. The papers, and the discussions that followed, showed clearly that the authors had reasonably adequate physico-chemical machinery at their disposal for testing and developing their theories, once they had decided on the theoretical mechanism to be tested; but it was soon obvious that the initial picture of the same or similar mechanisms differed markedly from author to author. This situation was to be expected in view of the great complexity of the total phenomenon under discussion, and it applied with particular force, as hinted above, to studies with the cellulose fibres. This situation lent support to the repeated contention by Dr. Neale that experimental attack must be pressed from as many different experimental angles as might be imaginatively possible. His own contribution consisted in a treatment of electrical field characteristics, due to ionic charges on the dyestuff particles and on the fibre surrounded by the aqueous dye solution, which control the approach of the dye particle to the fibre and modify the rate and magnitude of absorption which is ultimately effected by short-range forces. The experimental data were provided largely by the study of surface potentials at the fibre solution interface, and emphasized particularly the technically important influence of the presence of other small mobile ions such as sodium, chloride, etc.

The general picture of substantive dyeing processes with dyestuffs that are ionized in solution now appears to be fairly clear. The total process can be divided into three main steps: (*a*) a diffusion mechanism by which dissolved dye particles enter and leave an indifferent, porous, solid fibre, the equilibrium distribution of dye being imposed by purely mechanical conditions such as size, shape and velocity of the particles, and size and irregularity of the pores; (*b*) modifying this, an affinity factor, in which short-range chemical forces between dye- and fibre-substance encourage the retention of the dye; and (*c*) the creation of electrical double-layer effects due principally to the natural surface charge of the fibre and the immobilization thereon of dyestuff and other ions. The consideration of the last factor has been developed effectively by Neale and other workers to explain and evaluate the important technical effects of accompanying electrolytes in the dye-bath, since it has been shown, for example, that the Donnan membrane equilibrium principle can be used to account for ionic concentration differences within and without the fibre. Mr. J. Crank, of Courtaulds, drawing largely on the experimental data of Neale, further developed the study of the last factor. The original negative surface charge of the cellulose, augmented by the charges of adsorbed dye anions, is imagined to present a 'potential barrier' to the entry of further dye ions, a barrier which is penetrable only by ions which have a kinetic (activation) energy great enough to enable them to overcome the electrostatic repulsion. The free diffusion process is therefore modified by the fact that only a fraction, defined largely by the temperature, of the total external dye is available to penetrate a repulsive field the stopping power of which will be defined largely by the concentration of free and adsorbed dye and other ions. A method of calculating the magnitude of 'true' diffusion of the dye in cellulose (see *a* above) uninfluenced by chemical and electrostatic forces was worked out. Although the development of this method was necessarily incomplete, there is a promise that it may be possible to separate mechanical factors such as fibre orientation and dye particle-size from chemical factors in considering the dyeing of a specific dye on a specific fibre.

The chemical affinity factor was considered in detail by Dr. R. H. Peters of I.C.I. This work was based on the assumption by a number of previous workers that the attachment of dye to fibre is effected when, with favourable molecular dimensions in dye and fibre, hydrogen bonding can take place between specified active groups in the dye and hydroxyl groups in the cellulose. Following the adaptation by Vickerstaff and Peters of the Gilbert–Rideal equation, the standard free-energy change of the adsorption process was defined as the affinity of the dye. This value was calculated from adsorption isotherm data for the dyeing of a number of different forms of fibrous cellulose with a number of direct cotton dyes, with varying conditions of temperature and accompanying salt concentration. It was shown that the affinity so calculated is practically independent of the internal structure of the fibre for any one dye. The values of affinity as between one dye and another, dyes which, incidentally, deviate from each other very markedly in their exhaustion characteristics, are not of a very different order. The important deduction was therefore possible that the mode of attachment of dye to fibre is similar for all the dyes examined on all the fibres, the great individual differences observed in the dyeing behaviour of direct dyes being attributable to differences in the fine structure of the fibre and the state of aggregation of the dye particles.

A very similar picture was presented by Dr. Vickerstaff and Mr. D. R. Lemin as the result of an analogous treatment of the absorption of monobasic acid dyes by wool. The transfer of dye ions between solution and fibre was accomplished experimentally in different ways and calculations were made of the affinity. This was defined as the difference between the thermodynamic potential of the dye anion at unit activity in the solution and that of the same ion at unit activity in the fibre. The affinity of a particular dye calculated from the results of three different methods of determination, namely, direct adsorption, displacement of the dye from the dyed state by other anions, and competition of the dye with another for the fibre, led to reasonably consistent values. Here again, the affinity values were of a similar order of magnitude for all the dyes examined, so that a means seems to have been found for expressing quantitatively the strength of chemical attachment between dye and fibre, independent of many of the accidental properties of fibre and dye solution.

It is not the intention of this report, in thus singling out these two or three papers for special consideration, to diminish the value of the many other excellent ones that were discussed at the meeting. This group, however, with one other of a different kind, that of Dr. H. J. Selling of Delft, does appear to be of the greatest significance for the future, and the forward-looking spirit of the gathering was consistently maintained. Dr. Selling has made a heroic attack on a very difficult problem that has

always attracted the interest of scientific workers in the dyeing industry. This is the specification of shades and the control of the dyeing process by means of the colorimeter, a process which, up to the present, has required almost complete reliance upon direct visual judgment. It was shown that patterns dyed with comparatively simple mixtures of dyes can be analysed colorimetrically with sufficient accuracy to allow matching dyeings to be produced solely on the data thereby furnished. Technically, this is a very considerable achievement, and although the method is not yet ready for general introduction into the dye-house, the beginning thus made is extremely promising. If instrumental patterning becomes possible, the next step may be automatic control of the course of the dyeing operation, and the dyer's Utopia will be in sight.

Apart from the very pleasant social atmosphere which marked the whole of the symposium, encouraged by the excellence of its management and the character of the discussions, one further item must be mentioned as contributing very markedly to the general success. This was the readiness of some of the larger firms concerned with the textile industry to allow their research staffs to make serious and extensive contributions from the results of work carried out in their laboratories. This attitude, so important for general progress, has not always been so much in evidence, nor is it yet universal. The chief guest at the Society's dinner was Mr. A. H. Wilson, recently University lecturer in mathematics at Cambridge, who, after a distinguished career in the field of pure science, now holds an important administrative position in the industry as director of research and development of Messrs. Courtaulds, Ltd.; his considered compliments on the scientific activities of the Society of Dyers and Colourists will be a source of great encouragement.

H. A. TURNER

HOW FAR CAN BRITAIN FEED HERSELF?

THE Nutrition Society, at a whole-day conference held on October 25 at the London School of Hygiene, discussed "British Needs and Resources of Calories, Protein and Calcium". The Right Hon. Walter Elliott was in the chair.

The conference was planned some months ago, before the food situation became so threatening. In the first place, nutritionists were asked to give their considered opinion as to what amounts of food were needed in the United Kingdom to meet adequately the whole physiological needs of the human population, having regard to the dietetic habits of the British when unhampered by rationing. In the second place, a number of agricultural and fishery authorities, having been given a preview of the nutritionists' requirements, were invited to say how far British food resources could reasonably be developed to meet these requirements. The present alarming situation, when even minimal nutritional needs, despite the utmost austerity of rationing, are far from secure, was unforeseen when the conference was planned, but lent a sombre interest to the proceedings. One of the speakers remarked that though it was not on the agenda of the conference, an important and urgent question for discussion in the near future should be what we could do, having the new stringencies in mind, to meet from the agricultural and nutritional points of view a situation in which home production of food plus what Britain could buy with her failing credit from overseas threatened to be not merely below reasonable physiological needs, but even below minimal nutritional requirements for health and work.

In the first paper, Dr. E. R. Bransby, Dr. H. E. Magee, Mrs. M. C. Bowley and Miss B. R. Stanton gave a careful estimate, on the basis of the needs of the various age-groups in the population, of the amounts of different foods required to meet the requirements for calories, proteins and calcium of the whole population of the United Kingdom, both at the 1946 population of 48 million, and at the estimated 1964 population of 50 million (which would have a different age-group composition). They calculated these requirements on the amounts of food needed to enter the retail stage of distribution, not those actually eaten. The calories entering the retail stage are, in fact, some 10–15 per cent higher than those actually consumed, as determined by careful nutritional surveys—a gap for which, as yet, there is no adequate explanation.

The changes between the requirements as stated by Bransby *et al.* and actual pre-war supplies entail an increase of 48 per cent in milk and dairy products, of 56 per cent in potatoes and of 27 per cent in vegetables. Sugar needs are, however, below the pre-war level by 14 per cent, and the needs for fruit, fats, grain, meat, pork and eggs about the same as the pre-war level. It was stated that the diets as given provide not only all the physiological requirements for calories, proteins and calcium, but also those for all the other known nutrients. As regards protein, though for most age-groups more than half the total requirements were provided by animal protein, the authors thought that no clear evidence exists as yet as to what is the optimal amount of animal protein needed for a human dietary at different ages.

The discussion on the estimates given by Bransby *et al.* was opened by Mr. F. le Gros Clark. He doubted whether the menus which the first speakers had tabulated were really typical for those of the majority of the population of Great Britain. A good deal of our animal protein comes at present, and will continue to come, from milk, and he considered that the milk products/meat ratio should be increased. In estimating future requirements for the different types and qualities of food it is, of course, necessary to assume that the present relative prices will be maintained; but nevertheless, over even a short period of years, changes would undoubtedly take place which would greatly affect the demand for, and the consumption of, many items in the diet. In absence of rationing, and in view of the probable continuance of a high rate of employment and of wages, and of increasing education of the public in nutritional matters, he considered that it is highly probable that the demand for some of the more nutritious and tasty foods would exceed the needs as given in the first paper.

Prof. John Beattie mentioned experimental work on the calorie requirements of German prisoners under sedentary and under physically more strenuous conditions. It was found that, after loss of weight on a meagre diet, an immediate rise in food intake does not permit of increased expenditure of working energy until after a lag period, during which the lost reserves are being built up again. His view was that the adult male age-group should receive an

average of 3,500 calories, rather than the 3,000 that Bransby *et al.* considered sufficient.

Dr. E. C. Owen pointed out that the basis for the figures usually accepted for calcium requirements is not very secure. Individual requirements vary greatly. For various reasons, old people often get less calcium than they need. As regards the virtues of animal as compared with vegetable protein, he considered that the main factor is lysine, the irreplaceable amino-acid present in reasonable quantities in most animal proteins, but found to a much smaller extent in vegetable protein.

Dr. Isabella Leitch was dubious as to the basis of some of the previous estimates of food requirements. The right method is to draw up adequate menus for the whole population, and calculate total food needs on that basis. She could offer no satisfactory explanation of the gap of 10 per cent or more between 'food entering retail consumption' and that actually consumed in the house. This apparent wastage, however, varies greatly from one food to another. In the case of milk it is small. In estimating calorie requirements for the adult working population, little more than a guided guess is at present possible, since the actual physical work done is so difficult of assessment.

If the gap between the estimate of food production plus imports and actual food consumption were as small as 10 per cent, Prof. J. R. Marrack thought that those making this estimate were to be congratulated. His view was that the average calorie requirement of adult male sedentary workers was usually appraised at too high a figure.

Dr. Wood suggested that three tables of food needs might be prepared: (1) the minimum nutritional requirements for health; (2) the requirements from the popular point of view, where items like sugar would be high; (3) the requirements if food were given away free.

In replying to these comments, Dr. Bransby stated that the diets suggested by himself and his colleagues were intended to be appreciably above the minima, and, in fact, at the 'comfort' level.

The first paper to approach the question as to how far the nutritionists' requirements could be met from home production was given by Dr. E. T. Jones, who dealt with wheat, potatoes and sugar-beet. He considered that by increased efficiency and more intensive management, yields per acre of wheat and sugar-beet could be fairly rapidly increased to provide from home sources fully 50 per cent of the total needs of Britain for bread grains and sugar. Such an increase would depend on the liberation of more than 680,000 acres from potato production. This could be achieved, and our potato crop still meet national requirements, if cultural technique were improved, by the application of existing knowledge, to give an average yield of 10 tons of potatoes per acre.

In the second paper, dealing with home production of milk and dairy products, Prof. H. D. Kay stated that to satisfy the nutritional requirements of Britain for liquid milk alone would entail an increase of about 25 per cent above our present annual total of some 1,360 million gallons of milk leaving the farm. He considered that, without any increase either in numbers or quality of our existing dairy cattle, a 10 per cent increase in milk coming off farms could be achieved if 400,000 tons of concentrated feeding stuffs, in addition to the quantity grown or imported at present, could be provided. This represents only 6 per cent of our pre-war total import of concentrates. The remaining increase of about another 15 per cent in the milk coming off farms could be attained by improving the genetic quality of the dairy cows—but without any increase in their present numbers—by artificial insemination from bulls of the quality now in use in cattle-breeding centres. At present rates of progress in the development of artificial insemination, this would take some ten years. Additional feeding-stuffs would, of course, be needed *pari passu* with the increase in potential milk-yields of the improved stock. He also emphasized that the technical skill both of the dairy farmer and his cowman would have to increase at the same time as his stock was improved, if full use was to be made of the effect of artificial insemination from high-class bulls.

Dr. J. Hammond discussed the difficult question of increasing the home production of meat (beef, mutton and pig meat) despite the simultaneous demands for home-produced and imported feeding-stuffs which increased milk production and egg and poultry production would make. The total needs of meat, according to the nutritionists' requirements, are some 146 lb. per person per annum, of which only 38 lb. is at present produced in Great Britain. More beef might be produced at home by using good beef bulls, kept at artificial insemination centres, on the poorer milk-producing cows, to give colour-marked progeny that would not be mistaken for dairy animals. More winter feed for both beef cattle and sheep would be needed if meat production were to increase. As regards pig meat, any large increase would depend almost entirely on a rise in the supply of feeding-grain from abroad, though something could be done if more farms kept a few extra pigs which might act as scavengers and need relatively little food from outside the farm.

The possibility of increased fish supplies was considered by Mr. R. J. H. Beverton and Mr. G. C. Trout. The danger of over-fishing the North Sea was pointed out. It is considered that increased supplies of cod and other fish could be obtained from more distant fishing grounds, but this might entail the use of factory ships, since storage difficulties on the ocean-going trawlers are very great. As regards herring, there is no evidence whatever of an approach to the stage of depletion of reserves—many more could undoubtedly be caught fairly close to the British Isles. Here the difficulty is to dispose of the catches obtained in the peak period, by suitable methods of preservation. Increase of supplies of fish other than the herring undoubtedly lies in the exploitation of the more distant fishing grounds, and a 40 per cent increase in supplies is a possible attainment in a few years.

Egg production was discussed by Mr. E. T. Halnan. If larger quantities of suitable feeding-stuffs could be provided, he foresaw little difficulty in producing the increase of some 6,000 million eggs called for by the nutritionists. But with the greatest possible production of wheat and barley at home, and with a change in the rate of extraction of flour from the present 85 per cent down to the pre-war 70 per cent—neither of which seems likely—at least 368,000 tons of imported feeding-stuffs would be needed. From the figures he gave for present egg production, it appears that an unduly large number of eggs, apart from those legitimately produced by the 'backyard poultry keeper', are evading the official rationed channel at present.

The general discussion was opened by Dr. W. K. Slater. He emphasized that the additional production of food from sources in Great Britain means increased supplies of materials, for example, for additional factories and plant for extracting sugar-beet and for housing poultry. The training of the human element in more efficient methods of cultivation and of management of stock is likely to be a formidable task. He asked whether a true appreciation of the immediate future position in Great Britain is rather that the number of calories per person and the nutritional value of the average diet generally are much more likely to fall than to rise; and how far this fall could go without acute sequelæ.

Dr. N. C. Wright considered that a matter of immediate importance is the prevention of wastage, from whatever cause, of food already produced. We must find out, for example, exactly what happens to the 10–15 per cent of calories that vanish as between food 'moving into consumption' and food actually consumed in the household. He believed there is no escape from a greatly increased importation of animal feeding-stuffs from overseas if home-produced human food is to increase.

The importance of disease control and the part that the veterinary profession could play in preventing wastage were emphasized by Dr. W. R. Wooldridge. Prof. J. R. Marrack inquired whether, if the amount of milk required per head per day by the nutritionists has to be produced as liquid milk during the *winter* months, it would not thereby entail a considerable excess to liquid requirements at the production peak during spring and summer, which excess could provide a substantial quantity of dairy products.

Prof. A. W. Ashby, in summing up, said that we should face the fact that the standards in Great Britain for human food have been reduced to, and are likely to remain for some time, those of a rather poor peasant population. He considered that more co-ordinated consultation between the experts in nutrition and in food production and the administrative authorities is needed to give a sound basis both for the planning of increased food production at home and the carrying of these plans into effect. He criticized some of the figures given by those who had spoken during the conference on the possibilities of increased agricultural production, and thought that more statistical wisdom and mutual consultation might have made their estimates more helpful. He was very doubtful whether the yields per acre of wheat, etc., that one of the speakers had assumed as attainable in the near future, could, in fact, be reached. Competing requirements for feeding-stuffs to provide milk, meat and eggs have to be regarded from the point of view of efficiency of conversion of feeding-stuffs to human foods. Here the dairy cow is far superior to the bullock. He emphasized that under an effective system of price control the *relative* prices offered to the producer for the different farm products is the main directive factor in influencing relative volumes of farm output.

The chairman, in conclusion, mentioned the surprisingly large total tonnage, relative to the tonnage of human food, that is needed to feed the animal population of Great Britain, and emphasized the importance and economy of producing the maximum quantity of feeding-stuffs at home by the intensive application of existing knowledge.

The proceedings of the conference will be published in an early number of the *British Journal of Nutrition*.

OBITUARIES

Prof. J. Masson Gulland, F.R.S.

It was with a sense of severe personal loss that his many friends learned of the untimely death of Prof. J. M. Gulland, who was a victim of the railway accident at Goswick on October 26. He was a leading figure in the chemical world, a pioneer worker in several important fields of organic chemistry and biochemistry, and a man of outstanding personal charm.

John Masson Gulland was born in Edinburgh in 1898 and was the only son of the late Prof. G. Lovell Gulland, professor of medicine in the University of Edinburgh. Gulland was much devoted to his native land, and above all to his native city, which he frequently visited. He was educated at Edinburgh Academy and the University of Edinburgh, where he graduated in 1921, after serving as a second lieutenant in the First World War. At that period it was natural for a graduate of a Scottish university with an interest in organic chemistry to turn his eyes towards St. Andrews, and, having been awarded a Carnegie Scholarship, Gulland went there to work under Prof. (later Sir) Robert Robinson, whom he rejoined in Manchester and again later in Oxford. Gulland became a University demonstrator in chemistry at Oxford in 1924, and was appointed lecturer in chemistry at Balliol College in 1926. These appointments he relinquished in 1931, when he became senior assistant in biochemistry at the Lister Institute, London, and a reader in biochemistry in the University of London. In 1936 Gulland was appointed to the Sir Jesse Boot Chair of Chemistry at University College, Nottingham, which post he resigned in September of this year in order to take up a new appointment as director of research to the Institute of Brewing. This position had been vacant since the death of Sir Gilbert Morgan in 1940, and in reviving the post the Institute of Brewing planned to expand its research activities and to set up its own central research laboratories. At the time of his death, Gulland had already begun to apply himself with his customary vigour and enthusiasm to the execution of these plans. He was married in 1924, and is survived by his wife and two daughters.

Although he has a large amount of first-rate scientific achievement to his credit, Gulland was not quite so prolific a contributor to the original literature as some of his contemporaries. This is partly due to the formidable nature of the problems which he tackled; he never engaged in trivialities. It is probably due also to the fact that his earlier ardour for work at the bench tended to be subordinated later to his interest in organisation and administration, for which he had a real flair. He served on the councils of the Chemical Society and the Royal Institute of Chemistry, and was an honorary secretary of the Chemical Society during 1933–36. From 1932 until 1934 he was secretary of Section B of the British Association, and during 1935–37 he was recorder to the Section. During the early years of the Second World War he was senior gas adviser to the North Midland Region of the Ministry of Home Security, and during 1943–44 he was assistant director, Chemical Research and Development, Ministry of Supply. In this capacity he was attracted by the potentialities of alginic acid as a chemical raw material, and he took an important part in the establishment of the Scottish Seaweed Research

Association, the new laboratories of which in Musselburgh, Midlothian, were formally opened in September (see *Nature* of November 15, p. 662); Gulland was a member of the Board of Management of this Association, and chairman of its General Purposes and Chemical Advisory Committees. His department at Nottingham was a model of efficient organisation, and was well equipped for the researches which were carried out there under his inspiration and guidance. He had in recent years planned and supervised the erection of excellent extensions to the laboratories, and these are now playing a valuable part in meeting the heavy demands of the post-war period.

Only the barest reference is possible here to Gulland's scientific work, an appreciation of which will doubtless be published elsewhere. During his St. Andrews and Manchester days, he worked on the morphine group of alkaloids, and the constitution which is now generally accepted for morphine was first adumbrated in two classical papers, published in 1923 and 1925, by Gulland and Robinson. With R. D. Haworth, Gulland published a series of papers on the aporphine group of *iso*quinoline alkaloids (1928–29). New methods were devised by which were synthesized, among other compounds, bulbocapnine methyl ether and corytuberine dimethyl ether. Gulland also made other chemical studies of compounds of biological interest, including pellitorine, the pungent principle of *Anacyclus pyrethrum*, and the active constituents of *Taxus baccata* (1930–31). His work then followed a more biochemical trend and he investigated (with R. A. Peters) the reducing substances of pigeon's blood, and carried out a series of investigations on the oxytocic principle of the pituitary gland (1932–35), elucidating something of the chemical nature of this hormone. His major contributions to science are those carried out during the past twelve years on the chemistry of the nucleic acids, and of the nucleotides and nucleosides from which they are built up. Some of this work was summarized by Gulland in his Tilden Lecture given before the Chemical Society in 1943 (*J. Chem. Soc.*, 208; 1944). The pre-eminent part which the nucleoproteins play in the fundamental processes of life has become increasingly apparent in recent years, and gives added significance to Gulland's investigations in this field. It is a great misfortune to biological science that they have been so abruptly terminated.

J. W. Cook

We regret to announce the following deaths:

Prof. W. S. R. S. Lewis, professor of geography at the University College of the South-West, Exeter, on November 14.

Prof. Frank R. Lillie, emeritus professor of embryology in the University of Chicago, president during 1935–39 of the U.S. National Academy of Sciences.

Mr. W. J. U. Woolcock, C.M.G., C.B.E., a past-president of the Society of Chemical Industry, on November 13, aged sixty-nine.

NEWS and VIEWS

Nobel Prizes for 1947

Sir Robert Robinson, F.R.S.

The award of the Nobel Prize for Chemistry for 1947 to Sir Robert Robinson, president of the Royal Society, can have occasioned little surprise in view of his outstanding contributions to organic chemistry. They cover so wide a field that it is only possible to refer to a few of the more important of these. His early work on brazilin and hæmatoxylin, carried out in collaboration with the late Prof. W. H. Perkin, led to new pyrylium salt syntheses, which were later extended and applied to the artificial preparation of the anthocyanins, the chief red and blue pigments of flowers and blossoms, thus providing a final proof of the structures assigned to some of them by Willstätter. The possession of the pure synthetic specimens made it possible to devise simple quick tests for the anthocyanins contained in a few petals, which have proved to be of great value in genetic investigations. Of equal brilliance are his investigations in the alkaloid field. His simple synthesis of tropinone was rather the outcome than the cause of a theory of biogenesis of plant products put forward in 1917. This theory collated for the first time the apparently dissimilar alkaloidal constituents, and it has proved useful both in prediction and in criticism. The structures put forward for morphine and thebaine have found general acceptance. Undoubtedly his greatest contribution in this field has been his extended study of the chemistry of strychnine and brucine.

Sir Robert's mastery of the synthetic method and his penetrating insight is revealed in the long series of memoirs on the synthesis of the steroids. His work in this field has led, in collaboration with Prof. E. C. Dodds, to the synthesis of stilbœstrol, a useful and active œstrogen, which has found application in the treatment of certain forms of cancer. During the recent War he was the leader of the Oxford team engaged on the chemistry of penicillin, and it was in his laboratory that the main facts of its constitution were first elucidated. Finally, mention must be made of his contributions to the electronic theory of organic reactions. This theory was based originally on the discovery of C-alkylation of substituted aminocrotonic esters and was later extended by many other observations. Robinson's theoretical views, developed during the decade 1920–30, were subjected to severe criticism, but they have survived in almost unmodified form and they have now found general acceptance. It is not too much to say that the system first advanced by Robinson and his collaborators is the basis of the modern chemistry of organic chemical reactions. Robinson and his school have exercised a profound influence on the development of organic chemistry, not only in Great Britain but throughout the whole Commonwealth. Many of his former students and collaborators hold university professorships or fill important positions in chemical industry.

Sir Edward Appleton, G.B.E., K.C.B., F.R.S.

The announcement of the award of the Nobel Prize for Physics for 1947 to Sir Edward Appleton is one which will be received with great satisfaction by scientific men everywhere, and particularly by workers in pure and applied physics. Sir Edward

Appleton has achieved renown in two spheres, either of which might be considered as forming a sufficiently full life for a lesser man of science. He has for more than a quarter of a century been the most active worker in the field of radio physics, and during this period he has conducted research work of the most far-reaching importance. Since 1939, also, he has been secretary of the Department of Scientific and Industrial Research, a position which gives him the responsibilities and duties of the leading man of science in the Government service of Britain. Appleton displayed his great scientific ingenuity and experimental skill in December 1924, when he demonstrated the existence of the Heaviside layer as an ionized region of the atmosphere capable of reflecting electromagnetic waves. Shortly afterwards, he discovered another and higher region—the Appleton layer—from which the shorter radio waves are reflected after they have penetrated the lower region. From that time onwards Appleton has conducted a continuous series of researches on the characteristics of the ionosphere, and the part they play in determining the mode of propagation of radio waves round the earth. The techniques developed in the course of these investigations provided the foundations for the development of radar in Great Britain, while the results of the research on the ionosphere have proved invaluable in forecasting and allocating the most suitable frequencies for practical radio communication, broadcasting and other applications. More recently, Sir Edward Appleton, in co-operation with other workers, has devoted attention to the reflexion of radio waves from meteors, and has demonstrated that sunspots are powerful sources of very short radio waves.

His work during the war years as secretary of the Department of Scientific and Industrial Research was particularly onerous for, in addition to conducting the normal activities of the Department, he was called upon in 1941 to advise the Government on the magnitude of the effort to be devoted to the exploitation of nuclear energy, and later to set up a special section of the Department to carry out the necessary research work forming the British contribution to the development of the atom bomb. Sir Edward, who was elected a fellow of the Royal Society in 1927, has received many honours and awards in Great Britain and overseas, and he has been president of the International Scientific Radio Union since 1934.

Royal Society: Medal Awards

HIS MAJESTY THE KING has approved the recommendations made by the Council of the Royal Society for the award of the two Royal Medals for the current year as follows:

Prof. C. N. Hinshelwood, Dr. Lee's professor of chemistry, University of Oxford, for his distinguished work on the mechanism of chemical reactions, from the simplest gas phase processes to the complexities of cell division;

Dr. F. M. Burnet, director of the Walter and Eliza Hall Institute for Medical Research, Melbourne, for his distinguished work on bacteriophages, viruses and immunity; and for his contributions to the study of infectious disease as an ecological phenomenon.

The following awards of medals have been made by the President and Council of the Royal Society:

Copley Medal to Prof. G. H. Hardy, emeritus professor of pure mathematics, University of Cambridge, for his outstanding part in the development of mathematical analysis in Britain during the last thirty years;

Davy Medal to Prof. L. C. Pauling, director of the Gates and Crellin Laboratories, California Institute of Technology, for his distinguished contributions to the theory of valency and for their application to systems of biological importance;

Buchanan Medal to Sir Edward Mellanby, secretary to the Medical Research Council, for his distinguished researches on the physiology of nutrition, especially in relation to the causation of deficiency diseases;

Hughes Medal to Prof. J. F. Joliot, director of the National Centre of Scientific Research, Paris, for his distinguished contributions to nuclear physics, particularly the discovery of artificial radioactivity and of neutron emission in the fission process.

Physiology at St. Thomas's Hospital Medical School: Prof. H. Barcroft

PROF. HENRY BARCROFT, Dunville professor of physiology, Queen's University, Belfast, has recently been appointed to the University chair of physiology in St. Thomas's Hospital Medical School, London. Prof. Barcroft is a son of the late Sir Joseph Barcroft of Cambridge, and was educated at Marlborough College and King's College, Cambridge. He held the Harold Fry and George Henry Lewis studentships at Cambridge during 1927–29 and was awarded the Gedge Prize in 1930. He qualified in medicine at St. Mary's Hospital, London, after which he was appointed lecturer in physiology at University College, London, a post which he occupied from 1932 until 1935. He has held the chair of physiology at Queen's University, Belfast, from 1935 until the present time, and has carried out distinguished work on the control of the vasomotor system, and of the blood flow to the limbs and other parts of the body. His experiments were mainly carried out on the human subject and involved important observations on the physiology of syncope.

Jubilee of the Discovery of the Electron

THE fiftieth anniversary of the discovery of the electron was recently marked in Cambridge by an open meeting of the Philosophical Society at which a lecture on the history of the Cavendish Laboratory was given by Dr. Alex. Wood in that Laboratory. Dr. Wood was himself a research student under Sir J. J. Thomson and has been closely associated with the teaching work of the Cavendish Laboratory since 1905. His lecture was illustrated by exhibits of historical apparatus used by Clerk Maxwell, Rayleigh, Thomson and Rutherford. Among guests present were Dr. G. F. C. Searle, who as a boy was shown round the Laboratory by Clerk Maxwell shortly after it was built; Mr. J. E. Rolph, who was appointed as laboratory assistant by Lord Rayleigh in 1881; Mr. F. J. Lincoln, who was a laboratory assistant for fifty-three years, including forty-two years as steward; Sir William Dampier, who as W. C. D. Whetham joined the Laboratory in the very early days of Sir J. J. Thomson's professorship; and Lady Thomson, who as Miss Paget was a research student in 1889 and was married to J. J. Thomson in 1890.

British Books for Germany

AT the Information Centres of the Control Commission in the British Zone of Germany reference books are available for those who live near enough;

and special arrangements are planned for educationists and writers of school and university text-books. British books cannot, however, be purchased by Germans. The Control Commission has officially approved a scheme, put forward by the Agency for Intellectual Relief in Germany, under which the Agency will establish lending libraries for British books in key-centres of the British zone. The first library, containing some four thousand books, is being opened in Hamburg. Once the libraries have been established, German committees in each town will take over the management; it is expected that current expenditure in Germany will be covered by the borrowers' fees. A list of books needed, based on suggestions by German readers, has been prepared. Contributions are solicited towards the cost of books that must be bought; cheques should be sent to the honorary treasurer of the Agency for Intellectual Relief in Germany, C. P. Kininmonth, 4 Chapel Row, Wheeler End, High Wycombe, Bucks. Information relating to the scheme can be obtained from the Agency for Intellectual Relief in Germany, Foreign Office, German Section, 48 Prince's Gardens, London, S.W.7.

Import of Scientific and Technical Books

Replying to a question in the House of Commons, the President of the Board of Trade stated that he is prepared to consider the issue of licences for limited additional imports of technical and scientific books in English from certain European countries. Similar books in foreign languages from non-English speaking countries are licensed freely.

German Hydrographic Institute, Hamburg

The first annual report of the German Hydrographic Institute, Hamburg, consists of a 64-page booklet both in German and English (the former language being that of the official text). It gives a good account of the provision which has been made in Germany since the War for the performance of the various tasks formerly undertaken by the organisation which was the German analogue of the Hydrographic Department of the British Admiralty. Along with that account, which tells of work to do with marine surveying, the making and printing of nautical charts, the issue of nautical books, the testing of compasses, the observation and publication of magnetic values, the issue of time signals, and with many other matters concerning which information is needed by mariners and required by the naval side of the Allied occupying authority, there is substantial information bearing upon the present state of German oceanography.

Before the War, the science of oceanography had numerous practitioners in Germany, and, in addition to the two well-known and very large organisations devoted to its furtherance, there were several small scientific bodies of repute which worked in this sphere. The report records how plans were laid for the employment of about one-fifth of the large number of oceanographers to work upon tasks which should serve the interests of, and meet the needs of, that rump organisation which—it was approved by the Allied Control Council—had to be set up to carry out essential hydrographical duties in German waters. These scientific workers ultimately became Section 2 of the Institute which is the subject of the report. This, established initially by the British naval authorities, is now under the governance of a quadripartite board of four directors, functions in Hamburg, and is 'managed' by the British director, who is a captain in the Royal Navy. Considerable information is given concerning reports which have been written by various German marine scientific workers since the capitulation, and it is expected soon to start upon the issue of a periodical wherein such reports will be printed for circulation.

National Foundry College

The National Foundry College has been established and its board of governors nominated by the Minister of Education. The College will be housed in, and work closely in conjunction with, the Wolverhampton and Staffordshire Technical College. The board of governors is charged with the responsibility for providing national facilities for foundry education and research, in the form of full-time courses, vacation courses, refresher courses, and the like, and also for providing regional and local facilities for full-time, part-time day and evening courses, to cover the whole range of foundry education. Its first task will be the re-establishment of the full-time diploma course which was the main feature of the predecessor of the College, the British Foundry School, during 1935–39. This course will normally run for an academic year, and the first session opens on January 5. The course will cover the whole of the foundry industry, ferrous and non-ferrous, including grey, white and chilled iron castings, malleable castings, steel castings, and castings in non-ferrous metals, such as alloys of copper, tin, zinc, nickel, aluminium and magnesium. The diploma awarded to successful students will be endorsed by the Ministry of Education. There is no upper age limit for admission; a minimum of one year's practical experience in at least one branch of the industry will be required, together with a Higher National Certificate or a university degree, preferably in metallurgy or engineering, or a grade of membership obtained by examination of a professional institution in engineering, metallurgy or chemistry. Mr. J. Bamford, who was in charge of the British Foundry School during 1935–39, and who has since held important managerial appointments in the industry, has been appointed head of the National Foundry College.

Abstracts on Powder Metallurgy

Hitherto available in private circulation only, *Metal Powder Report* is now issued at an annual subscription of £3 7*s*. 6*d*. The report is a sixteen-page monthly abstract journal dealing solely with the production, treatment and use of metal powders, under the joint editorship of W. D. Jones and R. A. Hetzig. The use of such products in electronics, the metallization of glass and ceramic materials, iron driving bands, porous aluminium-base bearings, electrical contacts, magnetic materials, sintered plates for batteries, sparking plugs, and stainless steel powders for paints and lacquers, all of which are mentioned in the issues for September and October 1947, will give an indication of the surprising breadth of interest of this very new branch of metallurgy. All concerned with powder metallurgy in any of its aspects will find this publication of real use. It is available from Powder Metallurgy, Ltd., Commonwealth House, 1–19 New Oxford Street, London, W.C.1.

Biological Abstracts

A new section of *Biological Abstracts* (University of Pennsylvania, Philadelphia) will be published as from January 1948. The section (*J*—Abstracts of

Cereals and Cereal Products) will appear monthly except during the four summer months, when it will be bi-monthly. It will bring together abstracts of the entire technological and scientific literature on the cereal grains—wheat, corn, rye, oats and barley—and on all other grains such as soya bean, cotton-seed, buckwheat, etc., utilized by the milling and food industries. It will include contributions on plant breeding, cultural practices, varieties, soil and weather relations of the crops; physiology, diseases, insect pests; storage of grain and flour; milling machinery and techniques; plant sanitation; baking and nutritional studies on diets in which cereal and related products are important components; biochemistry of cereals and cereal products; enzymes; and industrial microbiology in so far as it affects the cereals and their products.

U.N.E.S.C.O. Fellowships

THE first two of the fellowships placed at the disposal of U.N.E.S.C.O. by the American Chemical Society have been awarded to men of science from Czechoslovakia. The successful candidates are Dr. Milos Hudlicky, assistant at the Institute of Organic Chemistry at Prague, and Dr. Ivan Vavruch, assistant at the Research Institute of the Czechoslovak Sugar Institute, also in Prague. It is hoped that both the new fellows will be able to take up their appointments early in 1948. One of the fellowships offered by the Belgian Ministry of Education under the same U.N.E.S.C.O. scheme has been awarded to Mr. Charalambos Vacalopoulos, who is studying international relations in Brussels. The organisation of a programme of fellowships of this kind is one of the most important of the aims of U.N.E.S.C.O., as it is designed to make it possible for scientific workers, teachers and others from war-devastated countries who were cut off from the outside world during the War to be made acquainted with the most recent developments in the field of their specialization.

Conference on Ethics and Science

IN July last year the British Social Hygiene Council held a conference on "The Problems of Communal Life: the Ethical and Scientific Approach", which proved so successful that the Council was asked to arrange something similar this year. In response to this request, a one-day conference has been arranged for December 4, and will take place in the Livingstone Hall, Tothill Street, Westminster, S.W.1. Its main theme will be "Society and the Individual", which will be considered under two headings, namely, "The Values Society sets upon the Individual", and "The Values the Individual sets before Himself". Ample time will be allowed for discussion at the end of both the morning and afternoon sessions and at an open meeting in the evening. Once again the aim of the Conference is to effect, in some measure, a synthesis between the spiritual and the scientific interpretations of life. The chair will be taken by Prof. Winifred Cullis and Dr. E. B. Strauss, and the speakers include Mr. L. J. F. Brimble, Father Leycester King, Canon Marcus Knight, Dr. E. H. Larkin, Mr. J. Mackay-Mure, Dr. Mary Smith, Mrs. Joan B. Thompson, Mr. Kenneth Walker, and Mr. R. Weatherall. Further information and tickets (members of the Council 2*s*. 6*d*., others 3*s*. 6*d*.) can be obtained from the British Social Hygiene Council, Tavistock House North, Tavistock Square, London, W.C.1.

Royal Society of Edinburgh: Officers for 1947–48

AT a statutory meeting of the Royal Society of Edinburgh, held on October 27, the following officers and members of council were elected: *President*, Sir William Wright Smith; *Vice-Presidents*, Lord Cooper, Prof. J. W. Heslop Harrison, Prof. W. M. H. Greaves, Lieut.-Colonel W. F. Harvey, Prof. James P. Kendall, Sir Ernest Wedderburn; *General Secretary*, Dr. J. E. Richey; *Secretaries to Ordinary Meetings*, Prof. Arthur Holmes, Prof. E. T. Copson; *Treasurer*, A. W. Young; *Curator of Library and Museum*, Dr. John E. Mackenzie; *Ordinary Members of Council*, Prof. E. P. Cathcart, Prof. A. Gray, Dr. J. R. Greig, Dr. W. A. Harwood, Prof. C. M. Yonge, Prof. A. D. Hobson, Dr. W. O. Kermack, Dr. John Weir, Prof. J. H. Gaddum, Prof. G. D. Preston, Prof. S. J. Watson, R. Ll. Gwilt.

Announcements

THE Hanbury Gold Medal for 1947 of the Pharmaceutical Society of Great Britain was presented on November 13 to Dr. Hans Flück, professor of pharmacognosy in the Faculty of Pharmacy of the Federal Technical Institute, Zurich.

THE Pedler Lecture of the Chemical Society will be given by Sir Ian Heilbron, professor of organic chemistry, Imperial College of Science and Technology, London, at the Society's rooms on December 4 at 7.30 p.m. He will speak on "Recent Developments in the Vitamin A Field".

DR. W. J. KEARTON, senior lecturer in mechanical engineering in the University of Liverpool, has been appointed to the Harrison chair of mechanical engineering in the University.

MR. JOHN WILSON, director of research to the British Rubber Producers' Research Association, has been appointed director of research to the British Rayon Research Association.

SIR CHARLES ELLIS, president and chairman of Council of the British Coal Utilization Research Association, has announced the following new titles in respect of the directorate of the Association: Dr. D. T. A. Townend, director-general; Dr. D. H. Bangham, director of research laboratories; Dr. E. G. Ritchie, director of engineering laboratories; Mr. J. S. Hales, director of domestic appliance laboratories; Mr. H. T. Hathaway, secretary and finance officer.

THE film "Nagana", introduced by Dr. P. J. du Toit at a meeting held at the London School of Hygiene and Tropical Medicine to discuss "D.D.T. and the Aeroplane in the Control of the Tsetse Fly and Trypanosomiasis in South Africa" (see *Nature*, October 11, p. 485), is now at the South African Scientific Liaison Office, 39 Prince's Gate, London, S.W.7, and is available on loan to scientific bodies wishing to show it. It is a 16-mm. colour film with sound-track.

THE Boron Agricultural Bureau announces that its work will be brought to a close at the end of December 1947. Its comprehensive collection of literature on the uses and functions of boron in agriculture, which has been assembled during the last eleven years, will be presented to the library of the Rothamsted Experimental Station, where it will be available for consultation.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Origin of Cosmic Ray Stars at Sea-Level

In an effort to identify the radiation responsible for production of the nuclear disintegrations and heavy charged particles occurring in the cosmic rays, we have carried out experiments with Ilford 'Nuclear Research' emulsions exposed on high mountains, and at sea-level with various absorbing materials. The results may be summarized as follows.

The ratio R of the number of single tracks to disintegration 'stars' has been measured at different altitudes, the plates and packing being identical in each case :

	Sea-level	12,000 ft.	14,500 ft.
Relative intensity of stars	1	10	20
R	26 ± 3	27 ± 2	$23 \cdot 5 \pm 2$

The constancy of R immediately suggests that the single tracks arise from stars produced in the material adjacent to the emulsion. This assumption is borne out by the fact that the proportion of single tracks attributable to alpha-particles and protons is, in fact, about what would be expected from the observed ratio in stars in the emulsion. Alpha-particles, with about one quarter of the range of the protons, produce some 7 per cent of the single tracks and 30 per cent of the tracks from stars.

On the above assumption, it is possible to calculate the value of R as follows. In examining a star in the emulsion, the identification of the disintegrating nucleus can, of course, only be based on the total charge carried by the emitted particles. It is thus found that the disintegration of a carbon, oxygen or nitrogen nucleus appears to be roughly eight times as probable as that of silver or bromine. Observations have therefore been made on the range and frequency distributions of tracks from stars produced by disintegration of the light or heavy emulsion nuclei respectively, and these data used to calculate the value of R when materials of various atomic number are in contact with the plates. (The thickness of the layer is assumed large compared with the mean range of the particles from stars, which is ~ 1 mm.) Making allowance for the effect of the glass of the plate, our results are as follows :

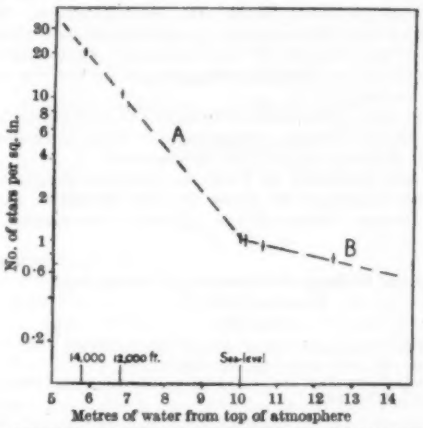
Covering material (1 cm. thick)	R (observed)	R (calculated)
Graphite	28 ± 2	~35
Paraffin wax	24 ± 2	~30
Brass	28 ± 4	~30
Lead	25 ± 2	~25

It is interesting to observe that there is no marked variation in the numbers of tracks with atomic number of covering material. Furthermore, the observed and calculated values agree as well as could be expected in view of the uncertainties in the calculation.

It can therefore be taken that the number of stars in the plate is proportional to the number of single tracks observed, and this fact has been used in order to obtain statistically significant results, in measuring the absorption coefficient of the star-producing radiation at sea-level. The variation in the number of single tracks (and hence presumably of stars) in plates exposed under different thicknesses of lead and paraffin wax was as follows :

Lead	Tracks per sq. in.	Paraffin wax	Tracks per sq. in
0·2 cm.	53 ± 5	1 cm.	49 ± 5
1 ,,	50 ± 5	5 ,,	56 ± 7
5 ,,	46 ± 5	17 ,,	51 ± 5
20 ,,	38 ± 3		

The data for single tracks under lead enables us to compare (see graph) the absorption of the star-producing radiation in a given mass of atmosphere (in metres of water-equivalent) with that in the same mass of heavy matter ; clearly the former is much greater[1].



(*A*) Absorption of stars in the atmosphere. (*B*) Absorption of single tracks in lead

From the above facts, and the absolute intensity of stars (~ 1 per c.c. 'Nuclear Research' emulsion per day) and single tracks ($\sim 0 \cdot 3$ per sq. cm. per day) at sea-level, we can make certain deductions regarding the nature of the star-producing radiation.

Bagge[2] has attributed the stars to photons ; but although the altitude variation of stars ($I = I_0 \exp(-1 \cdot 17h)$, where h is in metres of water) is almost identical with that of the soft component, the cross-section for photonuclear disintegration would have to be $\sim 2 \times 10^{-25}$ cm.^{2} to account for the observed star intensity ; this seems impossibly high. Further, the weak absorption in lead shows the star-producing radiation to be far more penetrating than photons. Heitler, Powell and Heitler[1] observed a 50 per cent increase in the intensity of the single tracks under lead at the Rossi maximum (1·2 cm.) on the Jungfrau, but the present experiments show that, if such an effect exists at sea-level, it is less than 10 per cent. It is also noteworthy that in cloud-chamber work[3] there has been a significant absence of correlation between stars and cascade showers. From these facts one concludes that photons produce only a small proportion (less than 10 per cent) of the stars.

It has also been suggested that neutrons are largely responsible for the stars. It will be seen from the table, however, that covering the plates with layers of hydrogenous material does not noticeably increase the number of single (proton) tracks, and a similar effect is observed at high altitudes. We are thus able to fix an upper limit to the flux of fast neutrons across the plates, and find it to be less than half per cent of the total radiation at sea-level. Assuming the capture of fast neutrons to be responsible for nearly all the stars, this in turn puts a lower limit to the cross-section for this process. One finds $\sigma \geqslant 2 \times 10^{-24}$ cm.^{2}, which appears quite irre-

concilable with the small absorption coefficient in lead. We therefore conclude that neutrons cannot account for more than about 10 per cent of the stars.

Although it is almost certain that several different types of radiation play a greater or lesser part in star production, the rapid absorption of this radiation in the atmosphere, as compared with dense matter, strongly suggests that a large proportion of the disintegrations are initiated by unstable particles undergoing radioactive decay in free space. Again, in cloud chamber experiments, events in which charged particles produce stars are comparatively rare. Furthermore, the intensity of charged mesons appears to increase only slowly with altitude. It is therefore probable that the particles responsible for the stars are uncharged.

I am indebted to Prof. L. Leprince-Ringuet for kindly exposing the plates at high altitudes, and to Sir George Thomson for valuable discussions and advice.

D. H. PERKINS

Imperial College of Science and Technology,
London, S.W.7.
Oct. 23.

[1] Heitler, Powell and Heitler, *Nature*, **146**, 65 (1940).
[2] Bagge, E., *Ann. Phys.*, **39**, 512 (1941).
[3] Hazen, W. E., *Phys. Rev.*, **65**, 67 (1944). Powell, W. M., *Phys. Rev.*, **69**, 385 (1946).

Solar Radio-Frequency Noise Fluctuations and Chromospheric Flares

Martyn[1] and Shklovsky[2] have suggested that plasma oscillations in the corona may provide a source of radio-frequency radiation. It has also been shown that radiation of a few metres wave-length must originate at heights above the chromosphere of the order of a solar radius.

If the plasma is excited by ultra-violet radiation, noise fluctuations should occur simultaneously with flares. If corpuscular emission is responsible, the radio noise should be observed later than the flare by an interval dependent on the average velocity of the corpuscles and the height at which the oscillations are excited.

Observations of radio noise at 75 Mc./s. made here during the past few months, combined with solar flare and radio fade-out data made available by the Commonwealth Observatory, Canberra, and the Watheroo Magnetic Observatory, provide the instances, collected in the table, of a delay of the right order between chromospheric disturbance and noise bursts.

The disturbances of 16.5.47, 4.6.47 and 5.6.47, described as 'violent', consisted of numerous bursts with a very high flux-level and a duration longer than the usual noise storm.

During the same period, and within the interval (02.00–06.00 G.M.T.) of observations at Perth and the half-hour preceding, five flares of importance 0–1 and three noise storms considered to be associated with simultaneous (but unobserved) chromospheric disturbances were reported from Canberra and three minor fade-outs from Watheroo. No radio noise was observed in connexion with these disturbances.

Appleton[3] and Allen[4] have observed noise fluctuations occurring simultaneously with flares or fade-outs. Appleton's observations were made at a time when the quasi-steady background flux was abnormal, that is, when the plasma was continuously excited. In such conditions ultra-violet radiation might be more effective. Allen's observations, made on 200 Mc./s., apply only to a proportion of flares and bursts and are not inconsistent with those tabulated here.

Some time ago[5], I reported observations of violent fluctuations in solar noise flux (03.14–29 G.M.T. on 2.8.46) at the same time as an eruptive prominence was seen at Watheroo to develop and fade on the solar limb. Since the Watheroo observations did not begin until 03.15 G.M.T., the possibility exists that the initial flare occurred sufficiently beforehand for corpuscular emission to have been responsible for the radio noise. On that occasion there was no fade-out, but another noise disturbance on 2.8.46, observed during 04.51–7 G.M.T., was preceded by a fade-out at 04.45, observed to be connected with another disturbance in the same region of the sun. Since the origin of the noise radiation is thought to be high in the corona—probably exceptionally high over the large sunspot group then on the limb—it would appear that serious absorption of the radio-frequency radiation did not occur in the direction pointing to the earth at that time, although normally conditions would

Date	Chromosphere		Radio noise (Perth)			
	G.M.T.	Observatory	Simultaneous	Intensity	Delayed	Intensity
7.3.47	05.00	Fadeout, Watheroo	G.M.T. nil	—	G.M.T. 05.20	single burst
14.3.47	03.00	Fadeout, Watheroo Flare, Canberra	03.02	very slight	03.14–16	many bursts, marked
2.4.47	01.57	Flare, Canberra	Observing from 02.00; quiet until 02.24			many bursts, marked
29.4.47	01.54–02.13 c.2·00	Flare, Canberra Fade, Canberra	nil	—	03.01	small
16.5.47	03.00	Fade, Watheroo	02.59–03.00 03.03–03.08	small but distinct	03.28–40	violent
21.5.47	04.45	Fade, Watheroo	nil	—	04.56	several bursts
21.5.47	01.30–43	Flare, Canberra	Observing from 02.00		02.12	single large burst
4.6.47	03.00	Fade, Canberra	nil	—	03.04–05 03.10–23	a few bursts* violent
5.6.47	02.20	Fade, Canberra	nil	—	02.37–03.02	violent†

* Noise at 03.04–8 on 200 Mc./s., observed at Canberra.
† Noise at 02.37–9 and 03.02–8 on 200 Mc./s., observed at Canberra.

not be favourable for observations of disturbances so far (80° W.) off the central meridian.

S. E. Williams
University of Western Australia,
Nedlands, W.A.

[1] Martyn, *Nature*, **159**, 26 (1947).
[2] Shklovsky, *Nature*, **159**, 752 (1947).
[3] Appleton and Hey, *Phil. Mag.*, **37**, 73 (1946).
[4] Allen, private communication.
[5] Williams and Hands, *Nature*, **158**, 511 (1946).

Photo-electric Fourier Transformer and its Application to Sound-Films

At the time of the publication of the accounts by Born, Fürth and Pringle[1,2] of the new instrument named by them the 'photo-electric Fourier transformer', we happened to be engaged in constructing a very similar instrument here. The principle of the apparatus and the main essentials of its design had been worked out by one of us (D. B.) in continuation of earlier work on acoustic spectra from sound-films; it seemed probable that the method would have advantages over the diffraction method previously employed[3].

Between our arrangement and that of the above authors the only significant differences are as follow. (*a*) We do not employ masks or silhouettes representing the functions to be analysed, as it has always been our aim to use actual sound-film. (*b*) Instead of producing the Fourier transforms of given functions singly, we seek to produce a continuous or running analysis as one function changes by gradual transitions into another. Our apparatus, therefore, includes a provision for moving the record of the function A (that is, the sound-film) steadily past the optical aperture, and simultaneously moving the photographic film B upon which the transformed function is recorded or transcribed. (*c*) The signals from the photocell are employed to give intensity modulation on the oscillograph screen instead of amplitude modulation; this is necessitated by (*b*) above. (*d*) In view of the fact that the higher audio-frequencies are registered on a sound-film as extremely fine periodicities indeed, we employ a grating with a greater number of more closely spaced elements; our grating is in the form of a disk 6 in. in diameter with 55 elements to the inch.

In other respects, such as the general arrangement of the disk, slit, photocell and oscillograph, and the use of a harmonic time-base synchronized electromagnetically with the rotating disk, our method coincides surprisingly closely with that of the above authors.

Early attempts to produce a satisfactory disk were made during the war period, but the work had then to be abandoned for more urgent matters. Shortly after the project was resumed, the paper of Born, Fürth and Pringle appeared, but we continued our work as we had a somewhat different object in view in constructing the instrument. Incidentally, when this is to be used to analyse actual sound-film, the requirements of the optical and amplifier systems become very stringent, presenting problems which could not be overcome immediately. The accompanying photographs show, however, that it is possible, using this apparatus, to display sound in the desired way. When a film record of speech sound is subjected to analysis, a succession of frequency-versus-time patterns is obtained, of the type illustrated by Fig. 1, which represents the word 'there', containing the diphthong ɛ + ə. From previous knowledge,

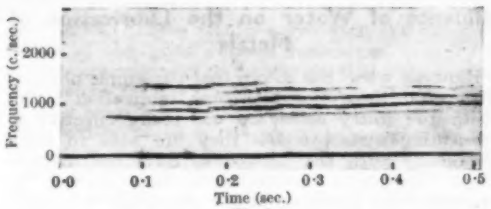


Fig. 1

Fig. 2

the acoustic spectrum would be expected to show a considerable number of harmonics of the vocal-cord pitch, with certain of the harmonics augmented in intensity by the resonances of the vocal cavities, and we find these characteristics clearly brought out in the photograph. Some pre-distortion in favour of the higher frequencies was employed during recording, and for this reason, and because of its low natural intensity, the fundamental pitch itself is not registered in this trace.

The zero-frequency line in the record is produced by the steady component of the light transmitted by the sound film. Neglecting small phase-difference effects, the oscillograph pattern is symmetrical about this line, so that if the whole pattern is photographed, the effect is as shown in Fig. 2, which is derived from the same initial film record as Fig. 1. Also, Fig. 2 illustrates the effect of using a smaller velocity for the film B in transcribing, so that the time-scale is more compressed. The changes in the vocal resonance regions, also the swing of the harmonic frequencies away from the axis, due to rising pitch inflexion, are now more easily appreciated by the eye.

It is not proposed to discuss here possible applications of this method of presenting vibration phenomena, which, of course, need not be limited to acoustic vibrations. In the field of communications, reference may be made to the recent survey by Gabor[4]. Also, while the present work was in progress, a series of articles has appeared[5] describing some remarkable recent developments in the Bell Telephone Laboratories, and their applications. The sound-spectrograph there described achieves in a striking manner the result aimed at in our own investigations, a fuller account of which will be published elsewhere. In conclusion, we wish to acknowledge great assistance from Mr. C. F. Coleman in the conduct of these experiments.

D. Brown
J. W. Lyttleton

Auckland University College,
Auckland, C.1, New Zealand.
July 31.

[1] Born, M., Fürth, R., and Pringle, R. W., *Nature*, **156**, 756 (1945).
[2] Fürth, R., and Pringle, R. W., *Phil. Mag.*, **37**, 1 (1946).
[3] Brown, D., *Proc. Phys. Soc. Lond.*, **51**, 244 (1939).
[4] Gabor, D., *J. Inst. Elect. Eng.*, **93**, 429 (1946).
[5] *J. Acoust. Soc. Amer.*, **18**, 1 (1946).

Influence of Water on the Lubrication of Metals

EARLIER work[1] has shown that the simple physical adsorption theory of boundary lubrication is inadequate; fatty acids are not really effective in lubricating metals unless they are able to react chemically with the surface to form the metallic soap. Gregory's measurements have shown, for example, that platinum is not effectively lubricated by a dilute solution of a fatty acid, whereas cadmium is lubricated up to the temperature at which the appropriate cadmium soap softens. Using a variety of metals he found a general relation between lubrication and chemical attack of the metal. With many metals, the chemical reaction of the fatty acid to form the soap occurs via the surface oxide film or in the presence of oxygen[2]. If this view is correct, we should expect that fatty acids would not prove effective lubricants even on metals such as iron or cadmium if oxygen is excluded.

Experiments were carried out on the lubrication of metal surfaces which were freed from oxide and surface films by cutting a fresh surface under the applied lubricant. The Bowden–Leben[3] friction apparatus was used throughout. By means of a specially designed cutting tool, a smooth shallow track was laid bare on the lower metal surface immediately before its passage under the loaded hemispherical slider used to measure the force of friction. The results show at once that a 1 per cent solution of lauric acid in paraffin oil is no more effective in lubricating the freshly cut metal surface than the paraffin oil itself. Further, if the lubricant is left on the surface for several hours, the lubrication remains poor, and this is true even if the temperature is raised to 100° C.

In other experiments, newly cut tracks were exposed to air for varying periods up to 24 hours; attempts were then made to lubricate them with the fatty acid solution. In the case of copper, lubrication was still ineffective even after 24 hours exposure. Magnesium and cadmium showed the same effect although to a lesser degree. In all cases, however, if the newly cut track was made wet with distilled water and allowed to dry before application of the lubricant, or was exposed to an atmosphere saturated with water vapour, good lubrication was immediately obtained. For effective lubrication, it is apparently necessary for *water* to have been present as well as oxygen.

In a series of corroborative experiments, the metal surfaces were abraded on emery paper under carefully dried benzene and kerosene, the lubricant being applied without allowing contact with the atmosphere. Here, again, the fatty acid solution was unable to provide good lubrication. Exposure of surfaces prepared in this way to distilled water in air caused lubrication to be effective.

Copper surfaces prepared in the normal way by abrading on emery paper under a stream of water are readily lubricated. A surface prepared in this way was heated to 200° C. and maintained at this temperature until an oxide film thick enough to give interference colours was formed. The specimen was then cooled in a vacuum desiccator to room temperature and treated with fatty acid solution. No lubrication was obtained. On covering an identically prepared oxide layer with a film of distilled water for one minute and then drying, the same fatty acid solution gave a low coefficient of friction.

Treatment of surface	Lubricant	Coefficient of friction (μ)		
		Copper	Cadmium	Magnesium
Abraded on emery under water.	1% lauric acid in paraffin oil	0·08	0·05	0·08–0·11
	Paraffin oil	0·55*		
Oxide film removed by scraping under lubricant	1% lauric acid in paraffin oil	0·9–1·4*	0·35–0·45*	0·40*
	Paraffin oil	0·75–1·15*	0·50*	
Abraded on emery under dry kerosene	1% lauric acid in paraffin oil	1·20*	0·30*	0·44–0·48*
	Paraffin oil	>1*		0·46–0·50*
Thick dry oxide film formed by heating	1% lauric acid in paraffin oil	0·8–1·0*		
Ditto, exposed to water and dried	1% lauric acid in paraffin oil	0·08		

In all cases, the load on the slider was 4 kgm. and the speed of the lower surface 0·01 cm./sec.; * denotes irregular or intermittent motion.

The main results are summarized in the table.

The results provide additional evidence for the view that chemical reaction, with the formation of a soap film, is necessary for the effective lubrication of metal surfaces by fatty acids. The second conclusion of theoretical and practical interest is that water may play an essential part in this chemical reaction.

The role of water has a number of possible explanations. It may be that it leads to the formation of a loose hydroxide or hydrated oxide layer of a character suitable for penetration and reaction by the acid. Alternatively, water may facilitate a local ionization of the acid molecules at the seat of reaction.

I wish to express my thanks to Dr. F. P. Bowden and Dr. D. Tabor for helpful discussions.

E. D. TINGLE

Research Group on the Physics and Chemistry of Rubbing Solids,
Department of Physical Chemistry,
Cambridge.
Aug. 1.

[1] Bowden, Gregory and Tabor, *Nature*, **156**, 97 (1945).
[2] Dubrisay, *C.R. Acad. Sci.*, **210**, 533 (1940).
[3] Bowden and Leben, *Proc. Roy. Soc.*, A, **169**, 371 (1939).

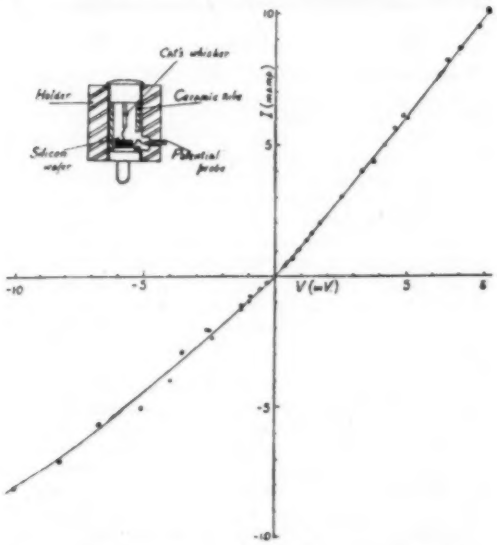
A Silicon - Metal Contact Resistance

THE rectifying action of a silicon crystal valve is a property of the contact between the silicon and a metal 'cat's-whisker'. In order to complete the circuit it is necessary to have a second silicon – metal contact the resistance of which must be small compared with that of the rectifying contact, so that the rectifying action is not cancelled out by the second contact.

It is usually assumed that the resistance of this second contact is negligibly small. During some recent measurements of silicon – metal contact resistances, an attempt was made to measure the value of this resistance in a commercial rectifier. The results showed that the resistance was small and could be neglected for most practical purposes, but it was large enough to introduce an error in determination of the crystal 'spreading resistance'[1] from the overall characteristics.

The crystal used was a *C V* 253 the performance of which lay within the normal spread. This type was chosen because its mechanical construction was convenient for the measurement. In this crystal a piece

of silicon about 2 mm. square and 0·5 mm. thick is soldered to a brass pin which is fixed in one end of a ceramic tube. A brass cap is fixed in the other end of the tube. The cat's-whisker is fixed in the brass cap and presses on the surface of the silicon to make the rectifying contact. A hole was cut in the ceramic tube opposite the silicon, and a second cat's-whisker was inserted through this hole to make contact with the side of the silicon wafer. For mechanical stability the crystal and the second cat's-whisker were fixed in an insulating holder. The second cat's-whisker was used as a potential probe so that by taking a potential lead from the crystal-pin the resistance of the 'good' contact could be measured with a potentiometer.



The results are shown in the graph. This is a current-voltage characteristic for the 'good' contact and is the mean of three sets of readings taken over an interval of about a fortnight. The graph shows that the contact has a resistance of about 1 ohm and is slightly smaller when the current flows from pin to silicon across the contact than when the current flows in the reverse direction. This direction of low resistance is the reverse of that for the rectifying contact of the crystal. It does not seem that this resistance could be attributed to the silicon itself because the resistivity of the silicon will be about 0·1 ohm-cm., so that the piece in the crystal should have a resistance of less than 0·1 ohm.

While the 'good'-contact resistance is small, it is not negligible compared with the 'spreading' resistance, which for silicon crystal valves is usually in the region of 20–50 ohms. To check this conclusion, the forward characteristic of the crystal was measured in the usual way, and then measured using the second cat's-whisker as a probe in the same way that the 'good'-contact resistance was found.

The spreading resistance was estimated by putting $R_s \doteq \delta V/\delta I$, where δI is the change in current produced by a change in voltage δV when a large current I is flowing through the crystal. The results found for the crystal used were: from overall characteristic $R_s = 59{\cdot}5$ ohms, using cat's-whisker probe $R_s = 58{\cdot}5$ ohms. These results agree with the measurements of the 'good'-contact resistance.

One cannot expect to draw more than very general conclusions from a single measurement of this sort. It does seem worth pointing out, however, that an effect exists which is not completely negligible and is, in fact, large enough to affect accurate measurements of the spreading resistance, which are sometimes necessary in studying the performance of rectifiers. It is possible that this effect might cause more serious errors in germanium rectifiers, where the spreading resistance may be so low as 1–2 ohms.

While it is reasonable to expect the contact resistance for germanium also to be reduced in the same proportion, it would seem desirable to check this in view of the conflicting results obtained with germanium crystals.

I wish to acknowledge the financial assistance given by the Department of Scientific and Industrial Research which made the work possible.

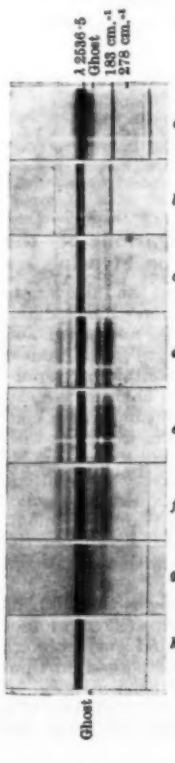
E. H. PUTLEY

Physics Department,
Queen Mary College,
London, E.1.
Aug. 1.

[1] Bethe, H. A., *Radiation Laboratory Report* 43—11.

Vibration Spectra of the Alkali Halides

As is well known, ammonium chloride crystallizes in the cubic system, its structure being of the rock-salt type above 450° T. and of the cæsium chloride type below that temperature. Menzies and Mills[1] found that at liquid air temperatures it shows in its Raman spectrum a strong line with a frequency shift of 183 cm.$^{-1}$. This observation is significant, since the frequency shift corresponds to the *Reststrahlen* frequency of the crystal[2] and hence indicates that the oscillation of the NH_4 groups against the Cl ions is Raman-active. The crystal powder technique employed by Menzies and Mills is, however, not well suited for the study of Raman spectra in the region of such small frequency shifts. Accordingly, a fresh investigation has been made with a well-grown single crystal and the λ 2536·5 excitation and the same technique as in my recent investigations with various other crystals. To enable the entire sequence of changes to be observed, spectra were recorded with the crystal held at a series of seven temperatures down to that of liquid air.



The series of spectra reproduced, while confirming Menzies and Mills' results for the liquid air temperature, reveals numerous other interesting facts. The spectrum becomes diffuse and faint when the crystal is heated up above room temperature. *Per contra*, when the crystal is cooled down, the spectrum brightens and also sharpens remarkably, exhibiting even above the so-called λ-point transition (243° T.), a group of three fairly well-defined Raman shifts of 92, 141 and 170 cm.$^{-1}$ respectively, with indications of two fainter ones at 107 and 195 cm.$^{-1}$. These persist far below the λ-point transition, becoming at the same time quite sharp and showing a progressive shift in their position with falling temperature. A remarkable change in their relative intensities also occurs at the same time. At liquid air temperatures, a new line with a frequency shift of 278 cm.$^{-1}$ unmistakably makes its appearance. This is quite sharp but faint.

There can be little doubt that the features seen in the spectra reproduced arise from oscillations of the lattice in which the NH_4 groups may be considered to move as single units and that, with the exception of the 278 cm.$^{-1}$ line, they represent the first-order vibration frequencies of the lattice. The observed discrete character of the spectrum and the sharpening of the lines with falling temperature are both in accord with the fundamental ideas regarding the vibration spectra of crystal lattices put forward by Sir C. V. Raman[3] and are, therefore, experimental evidence of his theory. That the vibration frequencies in this case are Raman-active in the first order, instead of being inactive as in the metallic halides, is evidently a consequence of the NH_4 group possessing only tetrahedral symmetry as compared with the octahedral symmetry of the metallic ions.

R. S. Krishnan

Department of Physics,
Indian Institute of Science,
Bangalore.
July 22.

[1] Menzies and Mills, *Proc. Roy. Soc.*, A, **148**, 407 (1935).
[2] Rubens and von Wartenberg, *Ber. Deut. Chem. Ges.*, 69 (1914).
[3] Raman, *Proc. Ind. Acad. Sci.*, A, **18**, 237 (1943).

Electron Microscope Investigation of the Action of Salt Solutions on Myosin

In previous work it was shown that the thiocyanate anion (0·05 mol. solution of sodium thiocyanate), which produces monsters with large notochord and hyper-evocation in Amphibia embryos[1], also induces a decrease in viscosity of solutions containing euglobulin *b* [2]. On the other hand, lithium chloride induces an increase in viscosity of these solutions, at a concentration (0·14 mol.) which produces monsters with reduced notochord and hypo-evocation. A similar effect has been found for the viscosity of solutions containing fibrillar particles (myosin, sodium thymonucleinate)[3]. In order to find what kinds of modifications were induced by the various salts in the myosin solutions, an investigation with the electron microscope was undertaken.

Rabbit myosin, prepared according to the methods previously used, was dissolved in a 1-mol. solution of potassium chloride, to which was added: (*a*) nothing; (*b*) sufficient of a 1-mol. solution of potassium thiocyanate (or iodide) to bring the concentration of thiocyanate (or iodide) to 0·5 mol.; (*c*) sufficient of a 1-mol. solution of lithium chloride to bring the concentration of lithium salt to 0·14 mol. After twelve hours at 0° C., these solutions were examined by means of the electron microscope, on preparations fixed and stained for one minute with 0·1 per cent phospho-tungstic acid, according to the method of Hall, Jakus and Schmitt[4].

Fig. 1 Fig. 2 Fig. 3

Preparations of myosin dissolved in potassium chloride alone (*a*) show clearly a fibrillar structure (Fig. 1); those treated according to (*b*) show the loss, sometimes even total, of the fibrillar structure (Fig. 2); those treated according to (*c*) show clearly a fibrillar structure. This is in full agreement with the finding of a lower viscosity of the myosin solutions after addition of potassium thiocyanate (or iodide)[3], and of loss of flow birefringence in myosin solutions when treated with these salts[5]. It is also in agreement with the finding of a higher viscosity of myosin solutions by addition of lithium chloride (up to a final concentration of 0·25 mol. [3]) and of flow birefringence of myosin solutions in lithium chloride[5].

It is difficult, now, to establish the relations between our findings and those of Jakus and Hall[6] on solutions of Szent-Györgyi's water-soluble myosin. The filaments of this myosin, by increase of the concentration of potassium chloride in the solvent, are transformed into a granular background and, if the salt concentration is then lowered, the myosin re-aggregates: our myosin is Weber and Edsall's myosin, that is, distinct from water-soluble myosin.

The present researches show that the effect of the thiocyanate anion on a fibrillar protein such as myosin, as shown by the electron microscope, is quite different from that of lithium chloride, in agreement with what could be expected from our viscosimetric researches[2,3].

I am grateful to Prof. D. Marotta, general director of the Istituto Superiore di Sanità, Prof. G. C. Trabacchi, director of the Physics Department, who supervised the work done with the electron microscope, which was constructed by him, and to Prof. D. Bocciarelli, who took the photographs.

Silvio Ranzi

Zoological Laboratory,
University, Milan,
and
Istituto Superiore di Sanità,
Rome.
July 31.

[1] Ranzi, S., *Nature*, **155**, 578 (1945). Ranzi, S., Tamini, E., and Storari, Offer E., *Ist. Lombardo, Rend. Sci.*, **79**, 161 (1946).
[2] Arosio, R., Citterio, P., Menotti, P., Ranzi, S., and Semenza, F., *Riv. di Biol.*, **38**, 153 (1946).
[3] Citterio, P., and Ranzi, S., *Rend. Accad. Lincei*, [(8), **3**, 150 (1947)].
[4] Hall, C. E., Jakus, M. A., and Schmitt, F. O., *Biol. Bull.*, **90**, 32 (1946).
[5] Dainty, M., Kleinzeller, A., Lawrence, A. S. C., Miall, M., Needham, J., Needham, D. M., and Shen, S.-C., *J. Gen. Physiol.*, **27**, 355 (1944).
[6] Jakus, M. A., and Hall, C. E., *J. Biol. Chem.*, **167**, 705 (1947).

Plasma-Electron Oscillations

DURING the past ten years, a series of investigations on the generation of high-frequency oscillations in thermionic tubes containing gas at low pressure has been made in this laboratory. The vacuum electromagnetic wave-lengths involved, usually well below 100 cm., and the conditions under which they appear, are in the main consistent with the view that they are plasma-electron oscillations with frequency approximately equal to $10^4 n^{1/2}$ (n is electron concentration), originating near the cathode[1,2]. The shortest wave-length which can be obtained is, however, not about 15 cm., as indicated by previous publications, but 5 cm. or less. Whatever its exact value, this is likely to be determined by the damping of the oscillatory motion of the electrons by collisions with ions when the ionization is very dense, or by collisions between electrons and gas-molecules at the gas-pressures necessary to produce high electron concentrations readily.

The amplitude and wave-length of the oscillations which can be transmitted to an external circuit depend markedly on position on the current-voltage characteristic of the generating tube. With an oxide-coated cathode, oscillations can usually be detected over wide sections of the characteristic. With a bare filament cathode, the oscillation regions are much more restricted. Often there will be one oscillation region in the infra-saturation section, one at about the saturation 'knee', and a third in the saturation section some volts above the 'knee'. No tube which has been studied containing gas at less than 0·01 mm. mercury pressure failed to generate oscillations over some part of its characteristic curve.

The amplitude of the oscillations which can be detected by an internal probe depends considerably on the position of the probe, but the wave-length of the oscillations does not usually change much as the probe is moved. A number of amplitude-distance patterns like those reported by Merrill and Webb[3] have been obtained; these, taken in conjunction with the fact that on a number of occasions when a discrete beam of primary electrons could be observed, oscillations could be picked up by the probe only when the beam struck the probe, provide evidence that at least one of the processes operative is velocity modulation of the primary beam in a comparatively small volume of oscillating plasma. From the variation of frequency along the saturation part of the characteristic, it seems that the position of the oscillating volume near the cathode is not constant. There is also evidence that two volumes of plasma with different electron concentrations may oscillate simultaneously and independently, from the fact that a probe will occasionally pick up different frequencies in different parts of a tube. This is in agreement with the theory of plasma electron oscillations, according to which the group velocity of the oscillations is almost zero[2].

The amplitude of the oscillations which can be obtained externally depends a great deal on electrode geometry, and upon the electrode to which the external circuit is connected. Thus with a simple coaxial electrode system with open ends, by far the strongest oscillations can be set up in a coaxial resonator if the central rod of the latter is joined end-on to the negative end of the filament, and if the filament is held taut and projects a little beyond the end of the anode. There is evidence that effects of this kind are connected in some cases with the movement of the electrons in the magnetic field of the filament-heating current, as the response of the resonator is reduced greatly by eliminating this. Further evidence for the existence of magnetic control is that an asymmetrical tube which normally gives feeble oscillations can be caused to give strong oscillations by bringing a bar magnet near it.

The way in which the plasma-electron oscillations are maintained is still not clear. One obvious possibility is that this is due to interaction between the primary electron beam and the plasma electrons, which depends on their relative speed, but the effects of magnetic fields suggest that some process which occurs with magnetrons may also come into play. It is also possible to draw an analogy between gas-filled diodes and 'hard' triodes giving Barkhausen – Kurz oscillations, with a potential maximum in the plasma of the gas taking the part of a positive grid in a 'hard' tube; it is, in fact, known from optical observations and probe measurements in some gas-filled diodes that a region of plasma with unusual properties extends outside the space-charge sheath on the filament for several times the diameter of the latter. Another possibility, suggested by Prof. K. G. Emeléus, is that plasma-electron oscillations outside the filament space-charge sheath are coupled with oscillations inside the sheath in which the potential minimum near the cathode forms and disappears discontinuously. With the complex conditions existing inside even the tubes of simple construction which have been studied, it would not be surprising if more than one of these effects, or others not considered here, should have to be taken into account ultimately.

The work described above has been carried out on behalf of the Director of Physical Research, Admiralty, and I wish to express my thanks to the Admiralty for permission to communicate these results.

E. B. ARMSTRONG
Department of Experimental Physics,
Queen's University,
Belfast.
July 24.

[1] Penning, *Physica*, **6**, 241 (1926).
[2] Langmuir and Tonks, *Phys. Rev.*, **33**, 195 (1929).
[3] Merrill and Webb, *Phys. Rev.*, **55**, 1191 (1939).
[4] Druyvesteyn and Warmoltz, *Physica*, **4**, 51 (1937).

Angle of Incidence of the Sun's Rays

THE radiant heat from the sun received by each square foot of ground affects a number of questions, such as evaporation from the soil, the growth of close-growing crops, and snow conditions. One of the factors involved is (the sine of) the angle of incidence of the sun's rays; and calculation of this angle, according to aspect and inclination of hillside, and sun's bearing and altitude, may necessitate the solution of many spherical triangles; so the following short cut may be worth noting.

The angle of incidence on a slope at S is equal to the angle of incidence on the parallel plane touching the earth at T, the nearer of the two possible tangent points. As this parallel plane corresponds to the level surface at T, the sun's altitude at T is the angle required; and if the position of T can be found, that angle can be read directly from altitude (-azimuth) tables, without worrying about spherical triangles, or even azimuth.

But the problem is to find T. It lies on the great circle through S, the course of which at S corresponds

ANGLE OF INCIDENCE OF SUN'S RAYS

Slope		0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	= Aspect
40° N.	Lat.	86	81·5	76	70	63·5	57	51	45	39	33·5	
	d Long.	0	3·65	4·35	4·55	4·5	4·3	4·1	3·85	3·65	3·25	
40° S.	Lat.	6	7	8	10	12·5	15·5	19	23	28	33·5	
	d Long.	0	0·4	0·85	1·25	1·65	2·05	2·45	2·75	3·0	3·35	

Lat. in degrees and decimals. d Long. in hours and decimals. Aspect is measured from N–S line. If it is easterly, d long. is plus; if westerly, minus.

to the aspect of the slope; and its angular distance from S is equal to the inclination of the slope. This great circle, and the latitude of T, and its d long. from the meridian of S, can be deduced from Towson's "Tables for Great Circle Sailing", which embody the solution of appropriate spherical triangles—if what Towson calls 'course' is interpreted as aspect, and what he calls 'distance' is interpreted as inclination. As the great circles are symmetrical about the meridian of S, the same values will serve for easterly and westerly aspects, provided that the correct signs are used when calculating hour angles.

Once the positions of T, according to aspect and inclination of slope, have been tabulated for a given latitude of S, the resulting figures can be used for any time of year, and any hour of day. Further, the times at which the slope at S gets and loses the sun, if it does so after sunrise or before sunset, will be simultaneous with sunrise and sunset at T.

To give an example, the accompanying figures from the table for lat. 46° N. will apply to the Alps, as they lie between 45° and 47° N.

P. J. H. Unna

4 Dean's Yard,
London, S.W.1.
July 1.

Random Association of Points on a Lattice

Moran[1] has given the first and the second moments for the probability distribution of 'black – white' joins when mn points black or white with probabilities p and $q = 1 - p$ respectively are distributed on a lattice of m rows and n columns. During the course of a detailed study of similar problems, I have worked out the first and the second moments for the distribution of the total number of joins between points of different colours when the lattice consists of points of k colours with probabilities $p_1, p_2 \ldots p_k$, such that $\sum_1^k p_r = 1$. These results for one, two and three dimensions are given below:

(1) One-dimensional lattice: m points on a line:

$$\mu_1' = 2(m-1)\,\Sigma p_r p_s$$
$$\mu_2 = 2(2m-3)\,\Sigma p_r p_s + 2(14-9m)\,\Sigma p_r p_s p_t + 4(5-3m)\,\Sigma p_r^2 p_s^2 + 8(3m-5)\,\Sigma p_r p_s p_t p_u$$

(2) Two-dimensional lattice: $m \times n$ points:

$$\mu_1' = 2(2mn-y)\,\Sigma p_r p_s$$
$$\mu_2 = 2(8mn-7y+4)\,\Sigma p_r p_s - 4(19mn-17y+10)\,\Sigma p_r p_s p_t - 4(14mn-13y+8)\,\Sigma p_r^2 p_s^2 + 8(14mn-13y+8)\,\Sigma p_r p_s p_t p_u$$

(3) Three-dimensional lattice: $l \times m \times n$ points:

$$\mu_1' = 2(3lmn-x')\,\Sigma p_r p_s$$
$$\mu_2 = 2(18lmn-11x'+4y')\,\Sigma p_r p_s - 2(87lmn-54x'+20y')\,\Sigma p_r p_s p_t - 4(33lmn-21x'+8y')\,\Sigma p_r^2 p_s^2 + 8(33lmn-21x'+8y')\,\Sigma p_r p_s p_t p_u,$$

where $y=mn+n, x'=lm+mn+nl, y'=l+m+n$. The summations are taken for all values of r, s, t and u different from one another. The joins considered are those along mutually perpendicular axes.

It can be shown that the distributions tend to the normal form when m, mn and lmn are increased.

The corresponding results when the lattices consist of $n_1, n_2 \ldots n_k$ fixed numbers of points from the different colours have also been worked out. These results, being more complicated, will be given in a detailed communication to be published shortly.

P. V. Krishna Iyer

Lectureship in the Design and
Analysis of Scientific Experiment,
Oxford. Aug. 11.

[1] Moran, P. A., *Nature*, **158**, 521 (1946)

Micro-Estimation of Sugars Separated on the Filter Paper Chromatogram

In view of the recent communication from Flood, Hirst and Jones[1] on this subject, a description of a method developed in this laboratory may be of interest. The same principle is used for the separation of sugars in a mixture, but a different method of extracting the separated sugars from the paper is employed, and the final estimation is carried out by a micro method free from the disadvantages associated with the Somogyi method and gives directly the weight of the sugar without the use of a reference compound. Certain of the established microchemical techniques developed in the Carlsberg Laboratory[2] are employed, and the scale of the method is correspondingly reduced. The procedure is, briefly, as follows.

By means of an accurately calibrated micro-pipette, replicate spots of known volume (4·05 μl. throughout these experiments) of the solution of sugars are placed at intervals of 3 cm. on the starting line of a filter-paper chromatogram, and the separation of the sugars is carried out as described by Partridge[3], care being taken to ensure that the solvent front remains straight and at right angles to the edge of the paper. The bulk of the solvent is then removed from the chromatogram *in vacuo*, a strip (on which will lie one complete set of the separated sugar spots) is cut from the paper and the position of these spots is revealed by development with ammoniacal silver nitrate.

Using this reference strip as a guide, the main portion of the chromatogram is then cut so that the individual sugar spots lie on pieces of paper approximately 3 cm. × 7·5 cm. long which are trimmed to a point, the sugar spot lying about 1 cm. from the tip. The subsequent treatments are also applied to blank pieces of the same size.

The pieces containing the sugars are freed from the chromatographic solvent by extraction in a Soxhlet condenser with anhydrous ether (petroleum ether, b.p. 60–80°, if xylose is present). The individual sugars are then washed off the pieces by a procedure analogous to the chromatographic separation, but using distilled water in place of the chromatographic solvent. The dilute sugar solutions are collected in micro-pipettes, the tips of which rest against the

points of the filter paper strips. (This method of extraction was suggested by Dr. A. J. P. Martin.) The solutions are transferred from the pipettes to cups cut in a block of paraffin wax, a total of 0·3–0·4 ml. of solution being collected from each paper. The solutions are then evaporated to dryness over phosphorus pentoxide.

To the paraffin cup 17 μl. of bicarbonate buffer *p*H 10·6 is added from a micro-pipette and the sugar dissolved with the aid of a fine, ball-tipped glass needle. The drop of sugar solution is then transferred by means of the same pipette to a waxed reaction tube[4]. Two further portions, each of 17 μl., of buffer are used to rinse the paraffin cup, the needle and the pipette, and are transferred in turn to the main solution in the reaction tube.

The estimation of the sugar is then carried out by the micro modification of the Willstätter and Schüdel method (stoichiometric oxidation by hypoiodite and titration of the excess iodine with thiosulphate) developed by Linderstrøm-Lang and Holter[4], oxidation being allowed to proceed for 45 minutes at 24° C.

Typical results obtained with a number of sugars using butanol-acetic acid-water[3] as the chromatographic solvent are given in the accompanying table, the figures quoted being the averages of four to six results from replicate spots run on the same paper.

Expt.	Sugars in mixture	R_F[3]	Taken (μgm.)	Found (μgm.)	Error %
1	Glucose	0·18	44	46	+ 4·5
	Lactose	0·09	76	76	0
2	Glucose	0·18	57	59	+ 3·5
	Lactose	0·09	107	105	− 2
3	Galactose	0·16	81	73	−10
	Maltose	0·11	94	91	− 3
4	Mannose	0·20	42	40	− 5
	Xylose	0·28	42	40	− 5

In its present form the method is capable of separating and estimating with an accuracy of about ± 5 per cent as little as 40 μgm. of a sugar, though the error of a single estimation is about twice as great. The Linderstrøm-Lang and Holter method of estimating sugars, however, is capable of estimating quantities of the order of 10 μgm. with a high degree of accuracy, and the present technique should be capable of refinement to allow of the separation and estimation of quantities of sugars of this order.

J. R. HAWTHORNE
Low Temperature Station for
Research in Biochemistry and Biophysics,
University of Cambridge, and
Department of Scientific and Industrial Research.
July 28.

[1] Flood, A. E., Hirst, E. L., and Jones, J. K. N., *Nature*, **160**, 86 (1947).
[2] Linderstrøm-Lang, K., and Holter, H., in Bamann and Myrbäck, "Die Methoden der Fermentforschung" (Thieme, Leipzig).
[3] Partridge, S. M., *Nature*, **158**, 270 (1946).
[4] Linderstrøm-Lang, K., and Holter, H., *C.R. Lab. Carlsberg*, **19**, No. 14 (1933).

Hydrolysis of Bi^{3+}. Oxygen Bridging—a New Type of Ionic Equilibrium

IT is well known that the ion Bi^{3+} easily reacts with water (is hydrolysed) so that hydrogen ions are set free. Very little is known, however, of the nature of the reaction products. In 1936 Holmqvist[2], and Prytz and Nagel[4] working independently, concluded that there are certainly not only mononuclear complexes ($BiOH^{2+}$, BiO^{+}) but also polynuclear complexes containing more than one bismuth atom. Holmqvist even tried to apply the law of mass action assuming definite formulæ, namely, $Bi_2(OH)_4^{2+}$ and $Bi_3(OH)_5^{4+}$.

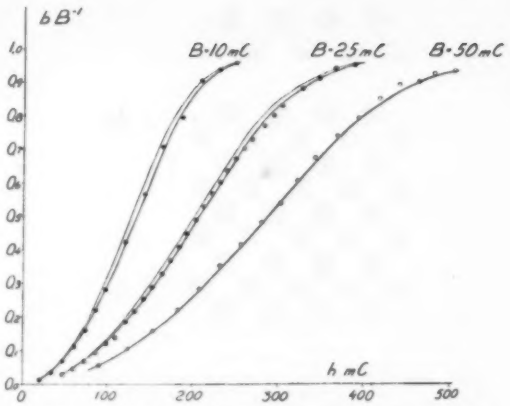


Fig. 1. $bB^{-1} = (Bi^{3+})_{free}/(Bi)_{total}$ AS A FUNCTION OF $h = (H^+)$. Circles = experimental values. The thick line for $B = 50$ millimol. and the thin lines for $B = 25$ and $B = 10$ millimol. are calculated with the constants $k_1 = 0{\cdot}065$ and $k = 2{\cdot}80$ mol. per litre. The thick lines for $B = 25$ and $B = 10$ millimol. are calculated with the best constants obtainable in each case: $k_1 = 0{\cdot}070$ mol. per litre, $k = 2{\cdot}95$ mol. per litre and $k_1 = 0{\cdot}060$ mol. per litre, $k = 3{\cdot}15$ mol. per litre

We have tried to measure accurately by E.M.F. methods the concentrations of free Bi^{3+} and H^+ in a series of solutions containing $Bi(ClO_4)_3$ or $BiOClO_4$, $HClO_4$ and $NaClO_4$ in such proportions that (ClO_4^-) is always equal to 3 mol. per litre.

Our results cannot be explained by assuming that only mononuclear complexes are formed, nor by assuming only one or two different polynuclear complexes. However, they agree surprisingly well with those calculated by assuming a simple mechanism ('oxygen bridging'):

$$Bi^{3+} + H_2O + Bi^{3+} = Bi_2O^{4+} + 2H^+ \quad (1)$$

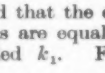
$$Bi_2O^{4+} + H_2O + Bi^{3+} = Bi_3O_2^{5+} + 2H^+ \quad (2)$$

$$Bi_3O_2^{5+} + H_2O + Bi^{3+} = Bi_4O_3^{5+} + 2H^+ \quad (3)$$

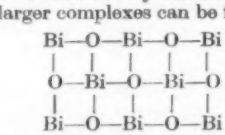
$$Bi_nO_{n-1}^{(n+2)+} + H_2O + Bi^{3+} = Bi_{n+1}O_n^{(n+3)+} + 2H^+ \quad (n)$$

We assumed that the equilibrium constants of all these reactions are equal to k, except the first one which is called k_1. Fig. 1 shows the fraction $\frac{(Bi^{3+})\ free}{(Bi)\ total}$ as a function of (H^+); the experimental points are in good agreement with the curves obtained by assuming $k_1 = 0{\cdot}065$ molar and $k = 2{\cdot}80$ molar.

The fact that k_1 is so much smaller than k can be explained if the higher complexes from $Bi_3O_2^{5+}$ onwards tend to form closed complexes such as



which should be favoured by electrostatic attraction. In this way larger complexes can be formed, such as:



These can be regarded as crystallization nuclei of the tetragonal $(MeO)_n$ sheets found in the crystal structures of many bismuth oxyhalides[1,5] and also in bismuth oxycarbonate[3] (Fig. 2).

It is not claimed, of course, that our picture of the reaction is exact. For example, the assumption of a common k is rather crude, and we have neglected the aquo acidity (which may become important at lower

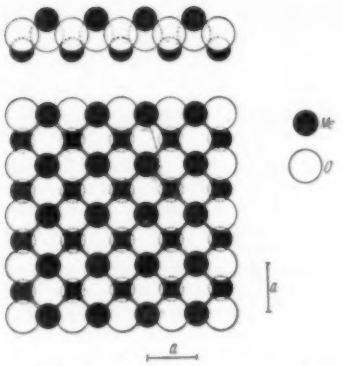


Fig. 2. TETRAGONAL METAL – OXYGEN SHEET IN BISMUTH OXYHALIDES, VIEWED ALONG a AND c AXES

(H^+) than those studied by us), and the possibility of rings of formula $(BiO)_n^{n+}$, such as Bi—O / O—Bi or Bi—O—Bi / O—Bi—O. It is hoped, however, that our description records the essential features of the Bi^{3+} hydrolysis.

It seems possible that a similar mechanism (in some cases perhaps with OH bridges) occurs also in the hydrolysis of other ions, such as Sb^{3+}, Pb^{2+}, UO_2^{2+}, and may be Fe^{3+}.

A detailed paper on this work will be submitted to *Acta Chemica Scandinavica*.

FREDRIK GRANÉR
LARS GUNNAR SILLÉN

Institute of Inorganic and
Physical Chemistry,
University, Stockholm.
July 14.

[1] Bannister, F. A., and Hey, M. H., *Miner. Mag.*, **24**, 49 (1935).
[2] Holmqvist, A., *Svens. Kem. Tidskr.*, **48**, 106 (1936).
[3] Lagercrantz, Å., and Sillén, L. G., to be published.
[4] Prytz, M., and Nagel, P., *Z. anorg. Chem.*, **227**, 65 (1936).
[5] Sillén, L. G., *Naturwiss.*, **30**, 318 (1942).

The Electron Affinity of ClO

IN a recent paper, Weiss[1] has given an estimate of the electron affinity of the ClO molecule, by a method which makes use of existing thermochemical data on the chlorine oxides and oxyacids. A necessary datum in the scheme of Weiss is the dissociation-energy of ClO, for which he chooses a value of 30·4 kcal. mol.$^{-1}$, quoting an early paper of Goodeve and Wallace[2]. Weiss appears to have overlooked a more recent publication by Goodeve and Marsh[3], in which the authors deduce that the ClO dissociation-energy is about 67 kcal. mol.$^{-1}$.

The latter figure is certainly more compatible with present views on the nature of the chemical binding in the ClO molecule. The resonance between the extreme structures :

$$:\ddot{\underset{\cdot\cdot}{Cl}}:\ddot{\underset{\cdot}{O}}: \quad \text{and} \quad :\ddot{\underset{\cdot}{Cl}}^{+}:\ddot{\underset{\cdot\cdot}{O}}^{-}:$$

(1) (2)

must result in a ground-state of *greater* binding-energy than that of the normal electron-pair Cl—O bond. The normal Cl—O bond has an energy value lying approximately midway between the Cl—Cl and O—O bond-energies. Although there is some doubt in regard to the value of the O—O bond-energy[4], there is little question that the correct value is not *less* than Pauling's estimate of 36 kcal. ; accordingly, the covalent Cl—O bond-energy may be estimated at not less than 47 kcal. The bond-energy in the actual ClO molecule must therefore be in excess of 47 kcal., by an amount equal to the resonance-energy of the interaction between the structures (1) and (2).

If the value (67 kcal.) given by Goodeve and Marsh is accepted as the best at present available, it may be combined with the value for the heat of formation of HClO aq. (26 kcal.) to give :

$$S(H^+) + S(ClO^-) + E(ClO) = 416{\cdot}3 \text{ kcal.}, \quad (1)$$

where the S terms are heats of solution, and the E terms are electron affinities. A further equation,

$$S(H^+) + S(OH^-) + E(OH) = 427{\cdot}8 \text{ kcal.}, \quad (2)$$

may readily be obtained from a knowledge of the heat of electrolytic dissociation of water, and the energy of rupture of the first OH bond in $H_2O(g)$[5]. Combining equations (1) and (2), it follows that

$$S(\bar{O}H) + E(OH) = S(ClO^-) + E(OCl) + 11{\cdot}5 \text{ kcal.} \quad (3)$$

The heat of solution of the $Cl\bar{O}$ ion is a matter for speculation, but it must certainly be less than $S(\bar{O}H)$; as a crude approximation, one might assume $S(\bar{O}Cl) \sim 3/4\ S(\bar{O}H)$, on the grounds that the chlorine atom in O^-Cl virtually blocks one of the four positions in which water molecules normally surround the O^- or $\bar{O}H$ ion. With this simplification, equation (3) becomes

$$E(OCl) \sim E(OH) + 1/4S(\bar{O}H) - 11{\cdot}5. \quad (4)$$

Bernal and Fowler[6] have estimated $S(\bar{O}H)$ at 105 kcal., and quote 276 kcal. for the term $S(H^+)$: substitution of these figures in equations (2) and (4) gives

$$E(OH) \sim 47 \text{ kcal.} ; \quad E(OCl) \sim 61 \text{ kcal.}$$

These values may be justified by an argument which is independent of assumptions regarding the probable values of the solution heats of ions. Representing the dissociation energies of the two processes

$$\text{(i)} \quad ClO \rightarrow Cl + O \quad - D_1$$

$$\text{(ii)} \quad Cl\bar{O} \rightarrow Cl + O^- \quad - D_2$$

by D_1 and D_2, and the electron affinity of the oxygen atom by $E(O)$

$$\text{(iii)} \quad O + e \rightarrow O^- + E(O),$$

the electron affinity of ClO may be written as :

$$E(OCl) = E(O) + D_2 - D_1. \quad (5)$$

Whereas the value D_1 is larger than the covalent Cl—O bond-energy, for reasons already discussed, it is probable that the bond-energy D_2 is almost identical with the normal Cl—O bond-energy. Resonance in the $Cl\bar{O}$ ion is restricted to that between the covalent-bond structure $:\ddot{\underset{\cdot\cdot}{Cl}}:\ddot{\underset{\cdot\cdot}{O}}^{-}:$, and the ionic structure $\overset{+}{Cl}\ \bar{O}$, and good reasons can be given for the expecta-

tion that the ionic-covalent resonance energy in this case should be small. Hence, we would expect $D_1 > D_2$, and $E(OCl) < E(O)$. Vier and Mayer[7] have recently measured $E(O)$ as 71 kcal.; we have pointed out that the value D_1 is greater than the normal Cl—O bond-energy by not more than 20 kcal. Thus, we would conclude that $E(OCl)$ must lie between the limits 51 and 71 kcal.

H. A. SKINNER

Chemistry Department,
University,
Manchester 13.

[1] Weiss, *Trans. Farad. Soc.*, **43**, 173 (1947).
[2] Goodeve and Wallace, *Trans. Farad. Soc.*, **26**, 255 (1930).
[3] Goodeve and Marsh, *J. Chem. Soc.*, 1332 (1939).
[4] See, for example, Skinner, *Trans. Farad. Soc.*, **41**, 645 (1945).
[5] See, for example, Weiss, *Trans. Farad. Soc.*, **31**, 966 (1935). Dwyer and Oldenberg, *J. Chem. Phys.*, **12**, 351 (1944).
[6] Bernal and Fowler, *J. Chem. Phys.*, **1**, 515 (1933).
[7] Vier and Mayer, *J. Chem. Phys.*, **12**, 28 (1944).

DR. SKINNER was good enough to send me a copy of his communication. More recently we have also been led to assume considerably lower values for the sum of electron affinity and heat of hydration of the ClO radical from a study of the photochemistry of hypochlorites in solution. This seems to suggest a value of $\{E(ClO) + S(ClO^-)\} \sim 105$ kcal.

I was, however, unaware of the ClO bond-energy value as given by Goodeve and Marsh to which Dr. Skinner has directed my attention.

Introducing this value into my previous calculations, the corresponding former figures should be diminished by the difference between the values of Goodeve and Marsh, and Goodeve and Wallace (~ 37 kcal.).

Thus one obtains $\{E(ClO) + S(ClO^-)\} \sim 128$ kcal. which, with the previously assumed value of $S(ClO^-) \sim 60$ kcal., leads to $E(ClO) \sim 68$ kcal.

JOSEPH WEISS

University of Durham,
King's College,
Newcastle-upon-Tyne 1.

Physiological Heterogeneity of Metaphosphate in Yeast

IT has been shown that when yeast is fractionated by repeated extractions with cold trichloracetic acid a species of phosphate, found in both the acid-soluble and the residue fractions, is identifiable as metaphosphate[1,2]. The co-existence in a yeast cell of metaphosphate in both acid-soluble and acid-insoluble forms suggests the possibility that these two may differ in their metabolic and physiological function. It is the purpose of the present note to report some recent observations which indicate that this is the case.

Resting cells (*S. cerevisiæ*, baking type, 48-hour culture) were incubated under anaerobic conditions while suspended in a medium containing 6 per cent glucose, phosphate buffer (*p*H 4·5) and P^{32} labelled inorganic phosphate. After 2 hours incubation at 30° C., these cells were extracted with 5 per cent trichloracetic acid for one and a half hours at 3° C. The resulting supernate (S_1) was treated according to the flow sheet, Fig. 1. In the precipitation with the magnesia mixture the test solutions were allowed to stand overnight in the cold. The precipitate

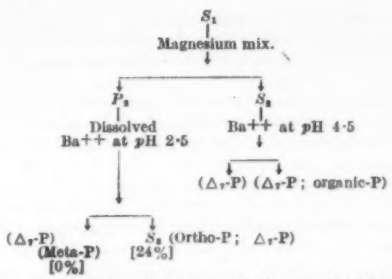


Fig. 1. Fractionation of the supernate from a cold trichloracetic acid extraction of yeast. The first step accomplishes a partial separation of metaphosphate by the use of a magnesia mixture which precipitates a mixture of meta- and orthophosphates. The metaphosphate can then be removed in a highly purified state by a precipitation with Ba++ at acid *p*H. As is indicated, the procedure does not remove all the metaphosphate from the original trichloracetic acid extract. Data in parentheses indicate type of phosphate compound found. Numbers in brackets give extent of equilibration with external phosphate in medium.

denoted as P_2 contained a portion of the acid-soluble metaphosphate and exhibited no activity, showing that no exchange had taken place. The orthophosphate contained in the supernate (S_2) showed that exchange had occurred to the extent of 24 per cent (based on initial P^{32} content of the phosphate in the medium).

If the Schmidt[3] method of fractionation is carried out following the cold trichloracetic acid extraction, there is obtained a residue (R_2) which can be shown to contain a large amount of 7-min. hydrolysable phosphate (completely hydrolysed to orthophosphate by treatment for seven minutes with 1 *N* hydrochloric acid at 100° C.). If this is treated according to the flow sheet in Fig. 2, another metaphosphate fraction (P_3 of Fig. 2) can be isolated. This metaphosphate is a highly active fraction and has, as indicated, exchanged to the extent of 24 per cent. In fact, this is the only fraction thus far examined which approaches in activity that of the internal orthophosphate of the cell.

It appears, therefore, that there are at least two different kinds of metaphosphate in yeast, differing radically in metabolic function. One, which is easily extractable by trichloracetic acid in the cold, presumably does not exchange with any other phosphate fraction in the cell. The other, which is apparently associated with a proteinaceous material, is one of the most highly active organic phosphates in the cell. This result is reminiscent of work reported many years ago by MacFarlane[4].

Aside from possible implication for the physiology of the yeast cell, the results reported here concern the validity of conclusions derivable from isotope

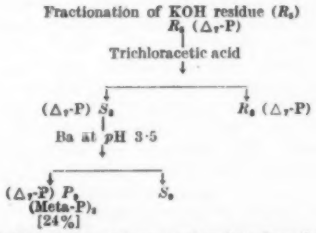


Fig. 2. Isolation of an active metaphosphate from the residue of a potassium hydroxide extraction of yeast. The procedure followed is essentially similar to that of Fig. 1. A trichloracetic acid extract is made, and an acid barium precipitation employed to separate the metaphosphate from other components. Symbols employed have the same meanings as in Fig. 1.

experiments. It is evident that the employment of chemical procedures which would recover all of the metaphosphate from the yeast cell as one fraction would mask the existence of physiologically different usages for the same chemical compound. Such a procedure could result in false conclusions with regard to the metabolic significance and function of such a compound.

Detailed accounts of the experiments described here will be published elsewhere. This work is being supported by a grant from the American Cancer Society.

E. Juni
M. D. Kamen
S. Spiegelman
J. M. Wiame
(Fellow of the Belgian American Educational Foundation)
Department of Bacteriology,
Department of Chemistry,
and
Mallinchrodt Institute of Radiology,
Washington University Medical School,
St. Louis, Mo.

[1] Wiame, J. M., *J. Biol. Chem.*, in the press.
[2] Wiame, J. M., *Bull. Soc. Chem. Biol.*, **28**, 552 (1946).
[3] Schmidt, G., and Thannhauser, S. J., *J. Biol. Chem.*, **161**, 83 (1945).
[4] MacFarlane, M. G., *Biochem. J.*, **30**, 1369 (1936).

Maintenance of Spermatozoal Motility in Dilute Suspension

The rapid immobilization of mammalian spermatozoa which occurs when an ejaculate is diluted with a large volume of physiological saline is the basis of Milovanov's[1] test of 'resistance', used in assessing the value of a specimen for artificial insemination. Milovanov attributes this immobilization to the toxic action of chloride ions. Chang[2] also remarks on the low motility, rate of respiration and fertilizing capacity of rabbit spermatozoa in dilute suspension. Our own observations confirm these findings; rabbit spermatozoa at a concentration of 20 million/ml. in Baker's[3] solution remain motile for two or three days at room temperature, whereas at a concentration of 0·4 million/ml. they are motionless within an hour or two. In our experience this rapid loss of motility is not attributable to a toxic action of chlorides, since chloride-free diluents have an identical action.

Dr. A. Walton had told us of an observation in his laboratory that an emulsion of liquid paraffin helps to maintain the motility of suspensions of spermatozoa. His suspensions were not, however, highly diluted. Emulsions of liquid paraffin with a little gum arabic added to assist emulsification in Baker's solution were therefore tried, and found to be highly effective in maintaining good motility for short periods of time (not more than 6–12 hours). However, it was then discovered that gum arabic alone, starch, glycogen, egg yolk, egg white, crystalline serum proteins and a number of other substances are equally effective. On the other hand, agar, gelatin, sodium silicate and catalase are entirely without effect. Supernatants from other suspensions of rabbit spermatozoa proved highly effective, and the sperm-free plasma from a vasectomized buck was also effective, but not as good as supernatants from whole semen, prepared from suspensions which had stood overnight.

Full details of these tests will be published elsewhere, but the following table is included to illustrate the striking results obtained. The motility of suspensions kept at room temperature is given a score of between 0 and 4, according to the activity of the spermatozoa[4].

Substances effective in maintaining the motility of suspensions of rabbit spermatozoa in Baker's solution at 4 × 10⁸ cell./ml.

Substance	Ejaculate	Motility score at hour					
		½	1½	2½	4	6	24
Controls at 2 × 10⁹/ml.	1	4	4	4	4	4	3
	2	3	2	2	2	2	1½
Controls at 4 × 10⁸/ml.	1	0	0	—	—	—	—
	2	1	½	0	0	—	—
0·25% W/V starch	1	3½	3½	3	3½	2½	0
	2	2	2½	2½	1½	½	0
0·25% W/V glycogen	1	3½	3½	3½	4	2½	0
	2	3	2	2½	2	1½	0
0·25% carbohydrate-free serum protein	1	3½	3½	3½	4	3	½
	2	3	2½	2½	2½	2½	½
0·25% serum protein containing 7% carbohydrate	1	2½	3½	3½	3½	2½	0
	2	3	2	2	2	2	0

Two features of this table need comment. First, there was sometimes a small rise in motility during the test, attributable to a rise in room temperature. Secondly, there was little or no motility in any but the control suspensions at 20 million/ml. at 24 hours, which demonstrates that the action of the various effective substances is not long maintained.

The capacity of such widely differing materials to preserve motility in dilute suspension makes it highly probable that their action is physical and not chemical. Therefore, the possibility was explored that they adsorb a toxic agent present in the diluent. Baker's solution contains traces of copper, lead and arsenic, and these seemed the most likely agents. However, neither special purification of the diluent nor the addition of relatively large excess of these metals affected the spermatozoa in suspension at 20 million/ml., which, surprisingly enough, are unaffected for the first six hours by 160 parts per million of copper or lead, or 48 parts per million of arsenic. Only copper eventually reduced motility, at 24 hours, in comparison with the controls. We were thus inclined towards a second hypothesis, that the various effective substances in some way prevent the escape of essential material, perhaps an enzyme, from the sperm cells. This receives support from the observation that repeated washing in Baker's solution does not cause immotility in suspensions at 20 million/ml. at a stage when the concentration of seminal plasma is reduced to that equivalent to dilution to 0·4 million/ml., but does cause immotility when further washings are given (controls washed repeatedly in the original supernatant, rich in seminal plasma, remain motile).

It is therefore concluded that the immobilizing effect of high dilution is probably due to the loss of vital material from the spermatozoa. The mode of action of the various effective substances which prevent the phenomenon is unknown. It seems unlikely, but possible, that they all contain some common impurity (like biotin) which is responsible for their effectiveness, and if so, it might operate in some manner other than the prevention of loss of intracellular material.

C. W. Emmens
G. I. M. Swyer
National Institute for Medical Research,
Hampstead, N.W.3.
July 30.

[1] Milovanov, V. K., "Osnovy iskusstvennogo osemenija—Principles of Artificial Insemination". (Moscow–Leningrad: State Publishing House, 1934.)
[2] Chang, M. C., *Science*, **104**, 361 (1946).
[3] Baker, J. R., *Quart. J. Exp. Physiol.*, **21**, 139 (1931).
[4] Emmens, C. W., [*J. Physiol.*, **106**, 471 (1947)].

Contribution of the Major Constituents to the Refractive Index of Milk

RECENT investigations[1,2] have shown the possibility of measuring the refraction in milk and the variations of the value under routine conditions of management.

A comparative examination of the refractive indices of more than 70 bi-weekly samples of milk and its rennet serum, prepared with one drop of Hansen's liquid rennet in 25 c.c. of milk, gave the following limits of variation of the constant. (In this proportion rennet caused no detectable addition to the refractive index of milk, as judged immediately after addition of rennet, and before coagulation set in.)

REFRACTIVE INDEX OF MILK AND MILK SERUM

Sample	Cow (R.I. 20° C.)	Buffalo (R.I. 20° C.)
Milk	1·3474–1·3506	1·3484–1·3534
Milk serum	433–447	436–453

These figures show not only that the elimination of casein reduces considerably the refractive index (fat having been shown to contribute nothing to this value[1]), but also that the variability of the constant of the serum is less than that of milk. Analysis of the entire data also showed that the refractive index of the serum does not always follow that of milk. This fact, and the lack of an exact linear relation between the refractive index and the solids-not-fat of milk[3], is perhaps caused by the differences in mutual proportions of the several constituents of milk. In other words, although two samples of milk (or of milk serum) may have the same solids-not-fat, the difference in the ratio of protein : lactose : minor constituents in the samples is responsible for the difference in refractive index.

Refractive index being a cumulative property, the presence of each solute adds to the refractive index of the water in milk. It has not been possible, so far, to determine the share of the several constituents in the total refraction, since there was no method of estimating the refractive index of milk. The method[1] recently devised enables such an estimation to be made.

A process of successive elimination of the major constituents and determination of the refractive index of the resulting fluids was used in determining the share of each. Casein (together with fat) was first eliminated with a drop of rennet. The lactalbumin and globulin in the rennet serum[3,4] was then removed by ultrafiltration with 'Cellophane' under a pressure of 20 kgm./cm.[2]. The refractive index and composition (including lactose[5]) of the milk sample and filtrates were also estimated. The excess of the value of the refractive index of the ultrafiltrate over that of a solution containing the per cent lactose in the sample determined the share of the minor constituents (mineral salts, non-protein nitrogen, citric acid, etc.). From a number of samples of cow milk so examined the following conclusions have been drawn.

In the refractive index of milk, proteins contribute, next to water, the largest fraction, lactose ranks next and minor constituents the least. But *in proportion to their percentages*, water, proteins, minor constituents and sugar contribute in descending order. Among the proteins, considering their proportion, the lactalbumin and globulin contribute much more than casein. These experiments consistently gave a refraction of 0·0021 gm. casein in 100 c.c. of milk. This is slightly higher than the values given by Robertson[6] (0·00152) and Brereton and Sharp[7] (0·00181) for a 1 per cent solution of casein in 0·1 *N* sodium hydroxide. The higher value in the present series of experiments is perhaps to be attributed to difference in dispersion and composition in milk and in the sodium hydroxide solution.

The data also show that milk sugar contributes the most constant value to the refractive index, and confirms the inference from the table above that the wide changes in the refractive index of milk are accounted for largely by the variations in the protein content of milk.

Thanks are due to Mr. B. N. Banerjee and Prof. V. Subrahmanyan for their interest in these investigations.

K. S. RANGAPPA

Department of Biochemistry,
Indian Institute of Science,
Bangalore.
Aug. 1.

[1] Rangappa, *Curr. Sci.*, **15**, 230 (1946).
[2] Rangappa, *Proc. Indian Acad. Sci.*, B, **25**, 86.
[3] Rogers and others, "Fundamentals of Dairy Science", 58, 196, 198 (Chemical Catalog Co., N.Y., 1928).
[4] Lloyd and Shore, "Chemistry of the Proteins", 448 (Churchill, London, 1938).
[5] Lane and Eynon, *J. Soc. Chem. Ind.*, **32**, 463 T (1923).
[6] Robertson, *J. Ind. Eng. Chem.*, **1**, 723 (1939).
[7] Brereton and Sharp, *J. Ind. Chem. Eng. Chem. (Anal Ed.)*, **14**, 872 (1942).

Determination of Benzene Hexachloride in the Blood of Cattle

DE MEILLON[1] reported that various arthropods are killed when fed upon rabbits which had received 'Gammexane' by ingestion. Similarly, Dr. S. G. Wilson, of the Veterinary Research Laboratories, Entebbe, Uganda, has found that the blood of cattle which had received benzene hexachloride by oral ingestion was toxic to tsetse flies for a considerable time after treatment[2]. Although biological tests thus showed that the insecticide was circulating in the blood, it seemed useful to apply the normal methods for the analysis of benzene hexachloride to estimation of the concentration in the blood of treated animals.

The simplest estimation of this insecticide depends upon the removal of three atoms of chlorine from each molecule of any of the benzene hexachloride isomers by refluxing with ethanolic potassium hydroxide and afterwards titrating the chloride ions present in the solution.

Outline of the method : 10 ml. of fresh oxalated blood were ground with anhydrous sodium sulphate and extracted with benzene. After evaporation of the benzene, chloride formed by dehydrohalogenation of the residue was determined by one of two methods. Method 1 is the Volhard procedure as used by Neal *et al.*[3]. This was found to be too insensitive for the quantities normally recovered from blood, and Method 2 was substituted, in which the silver chloride was filtered off before titration with potassium thiocyanate solution. Recoveries of 'Gammexane' (the gamma isomer of benzene hexachloride), added to blood from untreated animals, were satisfactory, and the error does not appear to be greater than 2–3 per cent in the range of concentrations which have so far been found in cattle bloods. Details of the method will be published later.

Some results are given in Table 1.

One experiment has been performed in which a calf was sprayed with the insecticide in oil solution (an extract of crude benzene hexachloride with a mixture of equal parts by volume of power kerosene and cotton seed oil).

TABLE 1. BENZENE HEXACHLORIDE FOUND IN CATTLE BLOODS AFTER ORAL INGESTION

Animal	No. of doses (1 dose = 0·25 gm./kilo)	Days after ingestion	Mgm. found per 100 ml. blood	Method
5592	4*	7†	2·3	1
		14	1·7	1
		19	2·1	2
		29	2·1	2
5593	1	1	2·5	1
		2	1·5	1
		7	1·1	1
		14	0·4	2
5606	1	1	1·7	1
		2	1·5	2
		3	1·1	2

* On four successive days. † Counted from the last of these days.

Although this work is of a preliminary nature, it does appear that the insecticide persists in the blood for some time after oral ingestion, the actual duration depending upon the size of the initial dose. In addition, there is some variation between individual animals. The method used does not, of course, show that the substance determined is benzene hexachloride as administered, but in conjunction with the biological results it would appear that this is so.

TABLE 2. BENZENE HEXACHLORIDE IN BLOOD AFTER SPRAYING THE SKIN

	Days after spraying							
	0*	1	2	3	4	5	6	7
Deposit on hide, mgm./sq. ft.	0	41	8	14	10	0	0	0
Concentration in blood, mgm./100 ml.	0	0	0·3	2·5	2·2	0·2	0	0

* Just prior to spraying.

By the spraying experiment, it is indicated that at least one cause of the loss of effectiveness of insecticides applied in oil solution to cattle is absorption of the oil through the skin. Thereafter the compound circulates for several days in the blood, as was found after oral ingestion.

I am indebted to Dr. Wilson for the use of some of his experimental animals in these determinations.

F. BARLOW

Colonial Insecticide Research,
Entebbe, Uganda.

[1] De Meillon, *Nature*, 158, 839 (1946).
[2] Wilson (in the press).
[3] Neal *et al.*, U.S. Pub. Health Rep. Suppl. No 177 (1944).

'DD' as a Means of Controlling *Heterodera rostochiensis* (Woll.)

INVESTIGATIONS during the past four years into the chemical control of *H. rostochiensis* have revealed that chloropicrin, ethylene dibromide, 'Dowfume G', 1–2 dichloropropene and 1–3 dichloropropane (crude 'DD') and two high boiling-point fractions of crude 'DD' are all effective soil fumigants. Because of its efficacy, ease in handling and comparative low cost, crude 'DD' is outstanding among these.

Concentrations up to 75 gallons of 'DD' per acre have been used with varying degrees of success. Soils ranging from almost pure sand to black fen (a deep, non-acid peat soil) were used; to effect a comparative kill a higher concentration was required in the latter than in the former. When 'DD' was injected at the 9-in. level, a 95 per cent reduction in plant infection has been achieved under field conditions in sandy soils. Recent laboratory experiments have shown that better results may be achieved when injection takes place at the 3-in. level.

Experiments involving the use of soil 'seals' have resulted in a 99 per cent reduction in plant infection.

The treated areas should be left undisturbed for a considerable period; also a full crop rotation should intervene before host crops are again exposed to attack. 'DD' has marked phytocidal effects, and seed potatoes have been killed when planted within seven days of soil treatment.

'DD' has been effective at a wide range of temperatures (33°–75° F.) and also in soils which have been air-dried or contain up to 40 per cent moisture by weight.

Slightly more ethylene dibromide than 'DD' was necessary to produce a comparative kill. The effectiveness of 'Dowfume G' is considered to be due to the methyl bromide present.

Weed control was also obtained by the use of 'DD' both in England and Southern Rhodesia. In England the plants controlled were all perennials with an existing root system at the time of soil treatment. Control was only obtained on land in Rhodesia which was treated and 'sealed', resulting in one instance in a 100 per cent control of ropoko grass (*Eleusine indica*, Gaertn.).

'DD' kills a number of soil pests, including wireworms, cutworms and centipedes. Although it is cheaper than all the other fumigants tested, the quantities required to obtain control of potato eelworm are such that the cost of treatment is still too high for economic use in England.

We would like to record the discovery of viable cysts of *Heterodera rostochiensis* adherent to soil on seed potatoes imported into Southern Rhodesia from Scotland. From two fields in Lincolnshire on which potatoes had not figured in the crop rotations for eleven years, small numbers of living larvæ were recovered from cysts of *Heterodera rostochiensis*.

A full account of this work will appear in the near future.

GEORGE C. MARTIN

Pest Control, Ltd.,
Cambridge,
and
Pest Control (Central Africa), Ltd.,
Salisbury, Southern Rhodesia.

What is a Dialysate?

THE meaning of the word 'dialysate' as defined in the Oxford Dictionary is indeed apt to induce mental confusion. It did so recently in my own mind, when I had to struggle through an American patent specification, in which the term was actually used in its Oxford Dictionary sense. In my opinion, as well as in that of my collaborators, Dr. Pirie is quite right, and his discussion[1] supports our decision to use the term 'dialysate' for the part which dialyses through the membrane.

With regard to the part of the system retained by the membrane, Dr. Pirie agrees that the term 'colloid' is unfortunate; this is so because that part need not be a colloid at all. Might I propose the use of the widespread and comprehensive word 'residue'? This term does not admit of any ambiguity, and applies equally well to the processes of distillation, sublimation and even to that of filtration.

H. G. DERX

Lever Brothers and Unilever N.V. Laboratory,
Zwijndrecht, Holland.

[1] *Nature*, 160, 198 (1947).

SCIENCE AND TECHNICAL EDUCATION IN GERMANY

International Congress for Technical Education

AN international congress of especial interest and significance was held at Darmstadt during July 31–August 9, under the auspices of the Technische Hochschule and with the full and generous co-operation of the American Military Government. For the first time in many years a large gathering of men of science and educationists were able to meet in Germany in free and open concourse. In spite of the difficulties of travel, more than fifty foreign visitors were able to be present, in addition to nearly five hundred Germans who came from all parts of Germany, including a small number from the Russian Zone. Fifteen British representatives were present. It was an experience which was of absorbing interest, especially for the insight which it gave into the present mental attitude of the teachers of science in Germany and into the physical conditions under which they must now carry on their work. The latter is the easier to describe. The universities and *technische Hochschulen* have suffered very severe losses of buildings and scientific equipment by the War, text-books are almost unobtainable, the teaching staff has been drastically reduced and, moreover, many—especially in the American Zone—are still awaiting trial by denazification courts. Those who are left are struggling, with a spirit which is wholly admirable, to provide a higher education to as many as possible of the greatly swollen numbers of students.

As in Britain the War has interrupted the education of many young men and women, and the influx of these into the universities has strained beyond the breaking point the very small resources of German higher technical education. It was with this background that the Darmstadt Technische Hochschule, largely through the energy of its rector, Prof. Richard Vieweg, called together this congress of representatives of technical colleges and industry.

The programme was arranged to discuss four main themes: (1) technics as an ethical and cultural opportunity; (2) the present state and trends of development in technical education throughout the world; (3) the admission of students to universities as related to social problems; (4) the exchange of professional ideas. Perhaps the best way to describe the spirit in which this programme was tackled is to quote in full the very moving inaugural address given by Prof. W. Brecht: "Seen from a distance, every university gives the impression of being a well-balanced institution of strong intellectual life emanating from the university as a whole. But from close at hand you discover that the specific character of the college is due to the manifold subjects, characters, temperaments and peculiarities of the teachers and to the versatility resulting from all these many shades of differences. Thus a problem of great weight may remain unsolved for a long time owing to the tension of discrepancies, until all of a sudden you realize that somewhere else, nay, everywhere, the problem has grown beyond personal solution and must be turned over to universal handling.

"This is the first time that a Technische Hochschule has opened her doors and made an appeal to the world of science as a whole, in order to bring a problem of vital importance before a great intellectual tribunal. This attempt, as well as the nature of the problem, are born of the present time.

"The exterior of the Technische Hochschule has been destroyed. All that is left are a few disconnected, separate buildings in an ocean of ruins, the remains of a city that was fatally wounded by the war. But harder to bear than the difficulties of reconstruction is the utter loneliness of the present and the sorrow caused by the obscurity of events that still envelop her in a veil that makes her aims and desires invisible to those who are standing without. Though still lacking in strength, she has raised her voice, hoping that it will pierce the dark wall surrounding her. She is not calling for help. She is fully conscious of the heavy burden of the past, and has no other desire than to prove that she wishes to live in order to be able to do her part in the good work.

"Sometimes things only seem to be good. When we are striving so earnestly and decisively for purity of intent, the good sought for must be genuine. Thus the call of our Technische Hochschule is at the same time a summons to solve a vital problem. The problem in question is how to educate the youth of to-day that will in the future apply the findings of natural science so that applied science, this form of the human intellect, now expressed in superhuman dimensions, may not glide farther into those icy regions, where the emotions of the heart are eliminated. How can our students be led to employ science, this truly noble instrument, in a manner worthy of the dignity of the human race?

"There is no doubt that technical schools and high schools have succeeded in giving their students the benefit of excellent technical training. There are people who say the success was too complete. For technical inventions have changed our lives fundamentally even so far as to influence the spiritual lives. There have before now been men, who saw danger looming up in this unprecedented development, voices warning us because science and the scientific way of thinking had become too strong and too independent and had thus lost all ties that should have bound them to the common roots of culture.

"However, we do know that the technical mind in itself is not evil. It is clear and precise and here as nowhere else, every step of its evolution is dependent on uttermost purity. Therefore technical science in itself is not evil. Its absolute value is determined by its aim, and not by the direct aim, but by the final, deepest ends it is to serve. Therefore we must dig down to the roots and we must penetrate into the borderland in which originate the possibilities of good and evil. Greater knowledge as to the peril involved and the danger emanating therefrom should raise technical thought and technical work into an atmosphere impenetrable to contamination and suited to the true nature of science. And it is this purpose that the education of our students should try to serve. This is a great and difficult task and as yet there are to be found but the very faintest attempts at such education.

"But we hope that this meeting of men of science and learning may assist in clarifying our aims and finding the means of putting them into effect."

Papers by English authors which were read and discussed at the congress were: "Science as a Means

of Christian Teaching", by A. Cameron, Cambridge; "Technical Education at Cambridge University", by D. B. Welbourn, Bedford; "Practical Training of Professional Engineers in England", by Sir Arthur P. M. Fleming and J. T. Kendall, Manchester; "Neuere Anweisungen und Formeln zur Bestimmung der zulässigen Belastung von Pfahlgründen", by C. Carty, London; "Engineering Education in England", by J. W. Bondi, London; "Remarks on Calculating Machines and Mathematical Tables", by L. J. Comrie, London.

Altogether some two hundred papers were read and discussed at the congress, some in the full session and some in the various sections. In addition, time was found for a large amount of informal discussion and lively argument. Nor was the social side forgotten; in addition to official receptions and informal *Bier Abende* there was an excursion to the lovely village of Lichtenberg on the Sunday, a performance of Bach's "Die Kunst der Fuge", and a performance of the new opera by Carl Orff, "Der Mond". This last is an artistic masterpiece, and was beautifully performed; but in its macabre and morbid outlook one seems to sense the subconscious hopelessness and tragic philosophy of the Germans to-day. This feeling of heroic tragedy has undoubtedly bitten deeply into the German soul; and after living for just a week in the ruins of Darmstadt and sharing, if only for a short time, in the present German way of life, one can realize how this must be. The congress was undoubtedly of inestimable value in helping to dispel a little of this gloom and uncertainty about the future, and its organisers were almost embarrassingly grateful for the presence and participation in the discussions of the foreign visitors. We, on our part, were equally grateful for having the opportunity to meet and talk with Germans who have miraculously kept safe, through the years of Nazism and the final ruin of their cities and intellectual life, a spark of intellectual freedom and probity and a capacity, one hopes, for rebuilding a new and more civilized Germany.

There is no space here to review the many papers presented at the congress and to record the discussions and the resolutions which were adopted. A full report of these will be published by the Technische Hochschule, Darmstadt. JAMES T. KENDALL

Berlin Technical University, 1947

THE Technische Hochschule in the Charlottenburg district of Berlin is one of the best-known institutions of its type in Germany and, like other universities in the British Zone, is now functioning as actively as circumstances permit, under the supervision of the Education Branch of the British Military Government. The following impressions are the result of a recent visit to the British sector of Berlin, during which the writer was engaged on lecturing to German students on behalf of the Control Commission for Germany. The observations are chiefly of a general character, but include a certain amount of detail appertaining to the writer's own field—physics.

During the War, the Technische Hochschule was extensively damaged and none of the main buildings remained entirely unscathed. The library was completely destroyed. In April 1946, when the surviving buildings were re-opened, the name was changed to Technische Universität. The main policy, formulated by the British authorities, is administered by a Control Commission liaison officer who deals with all matters concerning the Technical University and its relation to the broad educational system. The internal administration is carried out by a senate, which consists of fourteen members of the professorial staff, under the guidance of the Rektor, Dr. Walther Kucharski, who was appointed directly by the Control Commission.

At present the total number of students is 2,096 (1,850 men, 246 women), of whom 191 are non-German. There are the usual departments covering all branches of pure and applied science, and it is interesting that one of the most highly developed studies is architecture, which possesses a separate faculty and attracts large numbers of students of both sexes.

The students for the most part pursue their studies with an assiduity which is truly remarkable when considered against the forbidding background of German life. The gravity of the food situation has caused widespread 'black market' activity, and all sections of the population are compelled to participate to some extent if they wish to supplement their meagre rations. In addition to this problem (which confronts everyone), the students are handicapped by an acute shortage of text-books, note-books, stationery and similar material requirements. In spite of these adverse circumstances, great keenness is evident, coupled with receptiveness of mind and a mature, critical attitude towards educational matters. A marked sense of responsibility is noticeable at sessions of the Student Parliament, which has a fairly elaborate constitution and, as might be expected, is regarded as an essentially serious organisation. Invariably the attendance is large and the agenda lengthy, the various issues being debated in characteristically earnest fashion. There is, of course, the other side of the picture. The lighter side of student life is enjoyed with exuberance and vitality, a fact which is illustrated most effectively by the athletic meetings, where the considerable expenditure of energy appears to contravene any conservation principle!

So far as teaching is concerned, the main problems are inevitably those of accommodation and apparatus, and the experimental sciences, in which laboratory work is an essential part of the curriculum, are most seriously affected. Apart from bomb damage and the confiscation of all equipment connected with prohibited research, there have been heavy losses due to looting. In the huge main lecture theatre of the physics department, all the rows of seats and the electrical fittings were removed bodily. Owing to the scarcity of apparatus, there are virtually no laboratory facilities for advanced students, and overcrowding is unavoidable in the few laboratories which are in use. In the chemistry department, added difficulties are caused by the absence of fume cupboards together with inadequate ventilation systems. In the physics department the first-year laboratories are reasonably well equipped with the familiar experiments in general physics, heat, electricity and optics; neat design and high-quality workmanship are apparent in many of the instruments, but it is significant that there are no stop-clocks. Each experiment requiring a time measurement is provided with a device incorporating a revolution counter and a tiny synchronous motor driven via a transformer from the A.C. mains supply. A serious hindrance to laboratory work is the activity

of the ubiquitous pilferer. In a metre bridge set-up, for example, most of the components have substantial 'black-market' value, and unless precautions are taken to safeguard the apparatus there is a high probability that it will be found one morning in a somewhat despoiled state. Experience has similarly shown the extreme undesirability of leaving electric lamps in accessible positions.

Considerable progress has been made in building up the library again, but little can be done to improve the text-book situation. In the Western Zones of Germany there is no paper available for the printing of scientific books, although the position of journals is slightly better. The *Zeitschrift für Physik*, for example, has just reappeared under the editorship of von Laue. A few copies of British and American scientific periodicals have found their way into the library, but the impossibility of payment prevents a regular influx of foreign literature.

Similar conditions are encountered at the Heinrich Hertz Institut für Schwingungsforschung, which is associated with the Technical University by virtue of the fact that its director, Prof. G. Leithäuser, is a member of the staff, and of the senate, of the University. This Institute is concerned with the training of engineers in radio communications and allied fields, and possesses facilities for a small amount of research. All work is, of course, subject to the usual Military Government scrutiny, and no micro-wave equipment is allowed. Suitable apparatus for teaching purposes is in very short supply and the number of available experiments is thus severely limited; one class of twenty-four students is obliged to work in groups of six as there is sufficient apparatus for only four experiments. The main lines of research are: defects of mirror systems, the design of large horn loud-speakers for low-frequency reproduction and various radio circuit problems. A pulsed transmitter (wave-length range 30–100 metres) is being designed for ionospheric investigations.

So far as research in physics is concerned, facilities at the Technical University are practically non-existent, and of the three professors, C. Ramsauer, H. Kallmann and R. Frerichs, the two latter are supervising small groups working at the Kaiser Wilhelm Institut in Dahlem. This is situated in the American sector and therefore all projects are submitted to the American authorities for approval. Prof. Kallmann, in addition to theoretical work in wave mechanics, is working on the detection of α- and β-particles by a scintillation method, using organic fluorescent materials. The scintillations are recorded by a photo-tube and the responses are amplified and shown on a cathode-ray oscillograph. Prof. Frerichs is investigating the properties of cadmium sulphide photo-cells embodying photo-conducting strips about 1 cm. in length. Interesting results have been obtained with β- and γ-radiation, and further experiments are being carried out with X-rays.

As a concluding remark, it may perhaps be appropriate to mention one of the most notable features of academic life, namely, the universal eagerness for contact with the world outside Germany and in particular with Great Britain. There are many reasons why such schemes as student exchanges can take place on only a small scale at present; but a few students and lecturers from Germany have already visited Great Britain under the auspices of the International Student Service, and it is to be hoped that many other visits of this nature will be made possible in the future.

B. DONOVAN

German Physical Society in the British Zone

Autumn Conference

AN autumn conference of the German Physical Society in the British Zone was held during September 5–7 in the University of Göttingen. This conference gave striking evidence of German recuperative powers under considerable material difficulties, for it was attended by some five hundred physicists, and a formidable total of fifty-eight original papers was read. The conference was declared open by the president, Max v. Laue, and at this opening session the assembled members and visitors were greeted by Dr. R. Fraser on behalf of the Research Branch of the C.C.G. Although technically a British Zonal conference, in effect it was to some extent a meeting of the Physical Society for the whole of Germany, since delegates were also present from the French, Russian and American Zones. The younger generation was strongly represented and actively contributed, a fact calling forth the approval of many of the older German physicists. There is no doubt that organised physics in Germany has now recovered from the stagnant aftermath which followed defeat, and active research is being prosecuted from many centres.

Considerable satisfaction was expressed by many Germans present at the fact that a number of invited guests had arrived from abroad to read papers. These were: A. Michels (Amsterdam), V. L. Jordan (Copenhagen), B. Pippard, E. H. Sondheimer, D. Shoenberg (Cambridge), S. Tolansky (London), J. G. Wilson (Manchester), and all were received with warmth and given a particularly attentive hearing. The number of papers read was sufficiently large to enable the emerging pattern of interests in the post-war physics of Germany to be appreciated. Nuclear physics (in the wide sense) accounted for fifteen contributions divided into cosmic rays (5), nuclear reactions (5) and isotopes (5). There were nine papers on optics and spectroscopy, nine on metallic conduction and magnetism, and nine on acoustics. The remaining sixteen papers ranged widely, from quantum mechanics to diffusion pumps.

It will be gathered from this distribution that the pattern of interests is little different from what might have been expected from any German conference of pre-war days, and indeed the traditional emphasis so characteristic of Germany is well reflected. A matter of some considerable interest is the emergence of quite a number of unfamiliar place names as the centres of research. This may possibly be associated with war-time evacuation measures carried out to avoid the intensive bombing attacks, or perhaps for other reasons. In addition to many contributions from old-established and well-known university centres, papers were read about researches which had been carried out in such unfamiliar places as, for example, Hechingen, Weissenau, Tailfingen, Honnef, Horb, Markenkirchen, etc. It is stressed that these contributions were largely of the academic type normally expected from universities or associated establishments.

On each of the three days of the conference, a general review of a specific topic was given; these aroused a good deal of interest. The first, which constituted the opening paper of the conference, was delivered by W. Heisenberg. It was a clear and concise factual statement of the present position in

cosmic ray research, and was a valuable and comprehensive contribution. The second general review was by K. Wirtz. The author was a member of a research team engaged on the German uranium project, and in his paper he surveyed the limited achievements of the Germans in this direction. The third general paper was delivered by E. Meyer, who surveyed recent developments in acoustics in a comprehensive manner.

In addition to the formal papers read, some specially arranged symposia were held, the visitors from Britain taking part respectively in those on metallic conduction and interferometry. The social programme was indifferent, which was inevitable in view of the difficult conditions in Germany to-day. In view of these quite serious difficulties, the conference must undoubtedly be considered as quite an administrative achievement and augurs well for the future of physical research in Germany, despite the very serious shortage in the current materials of research.

S. TOLANSKY

Statistical Methods

THE first meeting of mathematical statisticians ever held in Germany took place on September 3–4, 1947, in Göttingen. It was attended by British statisticians who had been invited in an endeavour to overcome the difficulties which German mathematicians have experienced by having been cut off from foreign literature for a long time. The losses suffered by libraries in Germany and the impossibility of replacing their stocks contribute to the desire of German scientific workers to resume personal relations with British (or other) contemporaries.

The first meeting was opened by Dr. H. Münzner, professor of theoretical statistics in the University of Göttingen. Prof. P. Riebesell (Hamburg) then gave a critical account of the methods of *Grosszahlforschung*, showing that this version of the statistical analysis of mass production is either trivial or false. He discussed the relation of the normal curve to empirical distributions and suggested a test of the significance of two or more observational modes based on the idea of confidence limits (*Mutungsbereich*). S. Vajda (London) gave a talk on "The Algebraic Basis of the Analysis of Variance Method" in which he derived well-known formulæ for the tests of effects and interactions of any order by the use of orthogonal polynomials, and pointed out how various possible but different definitions of effects were due to different algebraic constructions (see *Nature* July 5, p. 27.)

In the afternoon, Miss M. P. Geppert (Kerckhoff Institute, Bad Nauheim) proved by examples that in estimating a parameter from a sample none of the three central measures, mode, mean, or median, of the fiducial distribution needs coincide with the maximum likelihood estimate. Prof. O. N. Anderson (late of Sofia, now at the University of Munich) gave an account of the problems of inverse probability and fiducial limits, stressing the necessity for deriving formulæ pertinent to a model "without replacement"; he also discussed a formula which should take the place of the t-distribution in the case of relative frequencies (which are not normally distributed) for small n and $p \neq (1-p)$.

On September 4, H. L. Seal (London) spoke on non-parametric tests and discussed some of them from the point of view of errors of the first and second kind. Prof. H. Münzner (Göttingen) introduced and solved an integro-difference equation which arises in the description of a 'cascade'-process where a particle multiplies k-fold, with probabilities dependent on k, at times t, the "intensity of multiplication" being dependent on t. Finally, Dr. E. Sperner (Oberwolfach) gave an account of his method of expanding meteorological functions in terms of eigenfunctions for the purpose of extrapolation.

An animated discussion took place in the afternoon at the Geophysical Institute, where the participants met by courtesy of the director, Prof. J. Bartels, whose notion of "persistence tendency" applied to time series (see *J. Amer. Stat. Assoc.*, June, 1940) gave rise to talks on a great variety of subjects, ranging from weather forecasts to the Heligoland explosion (see *Nature*, September 13, p. 350), seismic graphs of which were exhibited.

Many representatives of German statistics were, of course, unable to attend the meeting, but there was much interest in its proceedings. It was felt by all that the comparison of results obtained in ignorance of similar work done in other countries may prove stimulating, though at present Germany has scarcely anything to show which could compare with the fundamental progress achieved in Great Britain and the United States in the last twenty-five years or so. To facilitate the exchange of ideas it was decided to start work on an English–German dictionary of statistical terms, and to supplement it with proposals for a universal notation. Suggestions will be welcomed by Prof. H. Münzner (University of Göttingen, Germany, British Zone), or by the British visitors to the meeting.

S. VAJDA

Petroleum Geology

FOR the first time in the course of fifteen years, a meeting of those interested in oil geology was held in Hanover during September 9–11, about five hundred geologists and geophysicists being present. The State Secretaries of the administrative province, representatives of the Military Government, and numerous foreign guests were welcomed by Prof. Bentz, director of the Oil Department of the Reichsamt für Bodenforschung.

During the last fifteen years, several thousand wells have been drilled in north-western Germany, which have considerably increased the theoretical and practical information about the deep subsurface. The main part of the meeting consisted of reports from twenty-six German oil-fields. Their exploration by means of the most up-to-date methods has not only increased the production of the oil industry considerably but also provided much geological and geophysical material, which has helped to clarify the complicated tectonic, stratigraphic and facial conditions of the north-west German Saxonicum. Of the numerous Mesozoic rocks with oil-bearing possibilities from which the production of the north-west German oil-fields is derived, preference is still given to the Zechstein as the source rock of the oil; this hypothesis, however, was by no means placed in the foreground as the only one. The German oil industry owes its successes to this positive scientific attitude. It is only necessary to mention here the importance of the Ems district for German economic life. With regard to its reserves, this district is among the most important German oil provinces, and is thus also an important political factor.

Twenty oil-fields of north-western Germany are associated with salt domes, fifteen being of the flank type and five of the crestal type. Six fields are located on anticlines; for example, those of the Ems district. The source rocks are the main dolomite and the porous shale of the Middle Zechstein, the coral oolite of the Malm, the shell banks of the Wealden, the debris layers of the Neocomian, the chalk of the Upper Cretaceous, the sandstones of the Rhætic, the Lower Liassic, the Lower Dogger, Cornbrash, Valendis, and Lower Eocene. Almost all the fields are poor in gas content and subject to edge water drive. In 1946 the total production amounted to about 4,380,000 barrels.

In April 1947, geophysical results of a general interest were obtained from the blowing-up of the fortifications of the island of Heligoland (see *Nature*, September 13, p. 350). The depths of the North German area of sedimentation were established as approximately 3·1–6·2 miles, while the top of the sima near Göttingen was encountered at a depth of 17 miles, and at 25 miles at the edge of the Alps. The thickness of the continent, hitherto assumed as 37–62 miles, was thus considerably reduced; while fundamentally new knowledge of the major tectonic movements of the earth's crust was obtained.

Thirty-seven reports on the tectonics and palæography of Saxony, geophysical and petrographic methods of investigation, production engineering, and micro-palæontology afforded a comprehensive view of the state of German oil geology.

Many geologists were greatly stimulated by the meeting, and the synthesis between scientific research and its practical application was repeatedly emphasized. This synthesis alone has helped to achieve the results described during the meeting. A full report will be published in due course in the *Zeitschrift der Deutschen Geologischen Gesellschaft*.

An outcome of the meeting was the decision to found a Deutsche Gesellschaft für Mineralölwissenschaft and a Deutsche Geologische Gesellschaft for the British Zone.

W. Rühl

THERMIONIC EMISSION FROM OXIDE-COATED CATHODES

OXIDE-COATED cathodes have been used by the million for many years, but the explanation of the exact mechanism of the thermionic emission from them still presents many interesting physical problems. The summer meeting in London on June 14, arranged by the Electronics Group of the Institute of Physics, on recent work on such cathodes was most opportune, since the war-time use of the cathodes under pulse conditions, and the influence of recent theories of the properties of barrier-layer rectifiers and semiconductors, have stimulated further experimental and theoretical work, and are leading to a revision of views previously held.

Dr. F. A. Vick, of the University of Manchester, began the opening paper by summarizing the position in 1939. Activated cathodes were believed to consist of a mixture of barium and strontium oxides on a metal (normally a nickel alloy) core. Near the surface, strontium oxide was thought to predominate, and adsorbed on the surface a layer of barium, of concentration depending on the equilibrium between diffusion towards the surface and electrolytic movement towards the core during current flow. The high efficiency of oxide cathodes was supposed to be due to the lowering of the effective surface potential barrier by the adsorbed barium[1,2,3,4], analogous to the action of electro-positive layers on tungsten. Earlier workers had suggested[5,6] that the observed electron emission is determined by the potential barrier at the core-oxide interface, but by 1939 the role of the core had been relegated to assisting in the dissociation of oxides to provide some free barium.

The war-time use of oxide cathodes in valves used for pulse work directed attention to the fact that the peak saturated current in microsecond pulses could be many times (for example, 100) the normal saturated current at the same nominal temperature. Sproull[7] described careful experiments on the current-decay characteristics of the cathodes, with anode voltages kept constant for times varying between 100 and 2,000 microsec. and then switched off for times long enough for the cathode to recover. The saturation current rose to an initial high value and then decayed to an asymptote one-fifth to one-fifteenth of the initial value. Sproull suggested that as soon as the thermionic current starts to flow through the oxide, the concentration of the adsorbed barium layer commences to decrease from the equilibrium value under zero current to a new value depending on electrolytic movement through the oxide, and leading to a higher effective work function. Sproull inferred that electrolytic movement is easy through the oxide crystals but difficult across the crystal boundaries. Dr. Vick expressed the view that Sproull's theory is not the whole explanation of pulse effects, though some electrolytic movement of barium may be a contributory factor.

More recently, E. A. Coomes has published[8] an account of his work on the pulsed properties of oxide cathodes. He produced evidence to show that (i) a cathode giving good results under D.C. conditions is not necessarily a good pulse cathode, (ii) there may be a large temperature rise when heavy currents are drawn, (iii) a major limitation on the maximum pulse current is the onset of 'sparking' or 'flashing', (iv) the effect of the composition of the core metal on pulse properties may be considerable, pure nickel probably being the best. Coomes suggests a different reason for the enhanced emission, namely, that the electrons thermally excited into the conduction band of the oxide semi-conductor during the period between pulses are swept out during the pulse and added to the normal emission for a short period.

Dr. Vick went on to discuss work by Eisenstein and his colleagues on the use of X-rays to study the structure of oxide cathodes[9,10]. The results show, *inter alia*, that the crystal size of the oxide depends mainly on the maximum temperature reached during activation, that during life the composition of the surface layers becomes nearly pure strontium oxide (confirming previous results), and that special interface compounds are often formed at the core-oxide boundary, associated with an interface resistance *vs.* current characteristic similar to that exhibited by barrier-layer rectifiers. These and other considerations have led some workers to picture an oxide cathode as made up of the following sections: (*a*) metal core, (*b*) rectifying barrier layer, with direction of easy flow towards the core, (*c*) an excess semiconductor with dispersed interstitial barium, (*d*) a

region of strontium oxide with interstitial barium, (c) a surface potential barrier, the height of which may be influenced by an adsorbed barium layer. To determine the relative importance of the various factors and to fill in the details will require extensive work, both theoretical and experimental. Dr. Vick concluded the opening paper by outlining part of the programme of work recently commenced at the University of Manchester. C. A. Walley is applying the mass-spectrograph technique to identify the positive and negative ions emitted from oxide cathodes during activation and at all stages of life, and to correlate the ion currents with cathode structure and thermionic properties. W. Grattidge is studying methods of forming oxide cathodes without starting with the carbonates or using an organic binder, the aim being to obtain coatings with relatively simple and reproducible physical structures.

The next paper was contributed by Mr. D. A. Wright, of the Research Laboratories, General Electric Co. Ltd., Wembley, who dealt first with the factors affecting total coating resistance. He has applied the Mott[11] and Schottky[12] theories of barrier-layer rectification to the core-oxide interface. A potential barrier is to be expected at the interface, the difference between the work functions of the metal and of the oxide semi-conductor giving its height. The flow of electrons from core to oxide is then determined by barrier height, temperature, potential gradient through the barrier and the electron mobility in it. Mr. Wright's experiments using a magnesium–nickel core and a single probe embedded in the oxide have confirmed the existence of the barrier layer, with an effective resistance at low currents of 2–4 ohms per sq. cm., rising to tens of ohms at saturation. Hence at high currents the P.D. across the barrier layer can rise to some hundreds of volts, possibly leading to dielectric breakdown. The barrier layer may limit the emission available from the cathode, and its capacitance introduces a time-constant affecting changes in emission. Fineman and Eisenstein[10] have shown that the true coating resistance away from the barrier layer is of the order of 1 ohm per sq. cm. To lower the true coating resistance in the presence of a high-resistance barrier layer would give little overall gain in performance, but if the barrier layer resistance could be lowered at the same time, a considerable gain would be possible.

With a magnesium–nickel core, the height of the potential barrier at the core interface has been estimated to be about 0·7 eV. Mr. Wright's recent calculations show that the bottom of the conduction bands in BaO, SrO and CaO is not more than about 0·5 eV. below the zero-level. Conductivity measurements show that the impurity-levels of interstitial barium in barium oxide are between 1·0 and 1·5 eV. below the bottom of the conduction band. This gives a work function of 1·0–1·3 eV. Since this is of the same order as the observed work function for an oxide cathode, it indicates that any adsorbed barium on the surface has a small influence only on the work function. This is in agreement with the results of Nishibori and Kawamura[13]. In order to reconcile the value of the work function of the oxide with 4·6 eV. for nickel and the barrier height of 0·7 eV., it seems necessary to assume the presence of barium at the core-oxide interface.

Treating the observed emission as from an excess semi-conductor, assuming that the concentration of interstitial barium is 5×10^{17} atoms per c.c., the resistivity at 700° C. is calculated to be 300 ohm. cm., and the saturated emission 50 amp. per sq. cm., agreeing reasonably well with experiment. Methods of reducing effective resistance are being explored in the G.E.C. Research Laboratories.

Mr. Wright concluded his paper by suggesting a reason for the most effective cathodes being those with approximately equimolecular proportions of barium and strontium oxides. The reasoning is based on a minimum work function for interstitial barium in the surface layers of strontium oxide.

These two opening papers provoked a lively discussion which raised many points of detail for which there is no space in this brief summary. Mr. T. J. Jones (Admiralty Signals Establishment) directed attention to additional arguments in favour of an adsorbed barium layer being a predominant factor in controlling the effective thermionic emission. In one of his experiments[14] the outer layers only of an activated cathode were removed in a vacuum; this caused the emission to fall to about one thousandth. Subsequent operation at a suitable temperature restored the activity. Mr. Wright said that his own work and that of others had now stressed the importance of the core-oxide interface.

The last paper was contributed by Mr. A. J. H. Darlaston, of the Cosmos Manufacturing Co. Ltd., who gave a brief account of the preparation of oxide cathodes.

A fuller account of the proceedings at the meeting will be published in *The Journal of Scientific Instruments*.

F. A. VICK

[1] Koller, L. R., *Phys. Rev.*, **25**, 671 (1925).
[2] Becker, J. A., *Phys. Rev.*, **34**, 1323 (1929).
[3] Becker, J. A., and Sears, R. W., *Phys. Rev.*, **38**, 2193 (1931).
[4] Reimann, A. L., "Thermionic Emission" (1934), 212.
[5] Lowry, E. F., *Phys. Rev.*, **35**, 1367 (1930).
[6] Reimann, A. L., and Murgoci, R., *Phil. Mag.*, **9**, 440 (1930).
[7] Sproull, R. L., *Phys. Rev.*, **67**, 166 (1945).
[8] Coomes, E. A., *J. Appl. Phys.*, **17**, 647 (1946).
[9] Eisenstein, A., *J. Appl. Phys.*, **17**, 434 and 654 (1946).
[10] Fineman, A., and Eisenstein, A., *J. Appl. Phys.*, **17**, 663 (1946)
[11] Mott, N. F., *Proc. Roy. Soc.*, A, **171**, 27 (1939).
[12] Schottky, W., *Z. Phys.*, **113**, 367 (1939) and **118**, 539 (1942); *Phys Z.*, **41**, 539 (1940).
[13] Nishibori and Kawamura, *Phys. Math. Soc. Japan*, **23**, 378 (1940).
[14] Jones, T. J., "Thermionic Emission", 82 (1936).

GENERAL:
Blewett, J. P., *J. Appl. Phys.*, **10**, 668 and 831 (1939); **17**, 643 (1946).
Vick, F. A., *Sci. Prog.*, **35**, 82 (1947).
Weinreich, O., *Rev. Gen. Elect.*, **46**, 75 (1947).
Hermann, G., and Wagener, S., "Die Oxydkathode" (1944).

TYPHUS RESEARCH

IN recent years research upon typhus has provided one of the best examples of the beneficent effects of international co-operation in scientific work. By agreement with workers in the United States and Canada, publication of many aspects of the work done on typhus at the National Institute for Medical Research, London, and at the Royal Army Medical College Emergency Vaccine Laboratory, Everleigh, Wilts, has been withheld. A full account of important parts of this work has now been issued*.

The researches of twelve workers are here recorded and Dr. C. H. Andrewes contributes a general introduc-

* Medical Research Council. Special Report Series, No. 255: Chemotherapeutic and Other Studies of Typhus. By M. van den Ende, C. H. Stuart-Harris, F. Fulton and J. S. F. Niven, with C. H. Andrewes, A. M. Begg, W. J. Elford, M. H. Gleeson White, W. L. Hawley, K. C. Mills, F. Hamilton and C. C. Thomas. Pp. ii+246+11 plates. (London: H.M. Stationery Office, 1946.) 12*s.* 6*d.* net.

tion in which he explains that the report is not a comprehensive treatise on the clinical and pathological aspects of typhus, although it contains useful descriptions of these aspects of the disease, and especially of the Naples epidemic, which occurred between January and March, 1944, and is likely to have considerable historic interest. The report consists of five sections. Section 1 deals with the toxicity of two sulphonamides (*V* 147 and *V* 186), the highly promising activity of which against the murine type of typhus in mice had been studied earlier by Andrewes and his collaborators. Section 2 discusses in great detail the chemotherapeutic trials of these drugs in North Africa and at Naples, and the pathological studies associated with this part of the work. The two sulphonamides failed to fulfil the expectation raised by the earlier results obtained in mice, and the possible reasons for this failure are discussed. Section 3 describes a quantitative test for neutralizing antibodies against typhus Rickettsiæ. Section 4 discusses the comparison of four murine typhus vaccines in the laboratory and gives methods for the preparation of these vaccines. Section 5 compares the antigenic structure of a murine strain of typhus Rickettsiæ with that of a strain of epidemic typhus Rickettsiæ. The report concludes with two appendixes, one giving illustrative case reports and the other a list of drugs tested for chemotherapeutic activity against experimental typhus infection in mice.

It is impossible, of course, in a brief space to do more than indicate, as the preceding paragraph attempts to do, the solid value of every page of this report. It is an indispensable addition to the library of every worker on typhus and contains much that will interest the historian. Reading between the lines, one gets glimpses of Naples early in 1944, when the Italian civil authorities helped by their complete co-operation, although one of the immense difficulties encountered was the concealment of illness by the Italian community. The photograph published of an Italian deep underground air raid shelter, coupled with a little imagination and a dash of memory of Italy in happier days, makes it easy to visualize how a typhus epidemic can play havoc under the conditions then prevailing. The story of the dramatic effects of D.D.T. upon the lice vectors of the disease has been told elsewhere. Dr. C. H. Andrewes mentions that, when the method of intranasal inoculation of mice with material containing typhus Rickettsiæ was first used, all five of the workers using this method at Hampstead became infected, "fortunately with murine, not epidemic, typhus", and nine others working at Everleigh were also infected; but after the invention by van den Ende of a special inoculation box only one other worker was infected at Hampstead during the ensuing two and a half years, while none was infected at Everleigh. This gives an idea of the risks taken by these workers. Although there is still no specific drug which has a specific action on typhus Rickettsiæ, nobody will doubt that one will eventually be found. When it is found, it seems likely that the study of its use will provide valuable information about possible chemotherapeutic methods of attack upon other organisms which have so far resisted all drugs used against them. As this report says (p. 126), modern chemotherapy of bacterial diseases is supposed to depend largely upon interference with essential metabolic processes of the organisms, but a similar basis for attacks on the virus and Rickettsial diseases may be impossible, because these organisms depend upon "parasitism of the enzymes and essential metabolites of the host's cells". Perhaps future work, using this idea as a clue, will succeed in mastering these causes of this devastating disease.

G. LAPAGE

JAMES HUTTON: GEOLOGIST AND AGRICULTURIST

THE first ordinary meeting this session of the Royal Society of Edinburgh was held on November 3 and took the form of a commemoration of the hundred and fiftieth anniversary of the death of James Hutton [see also p. 694].

Sir Edward Bailey, who spoke on "James Hutton: Founder of Modern Geology: 1726–1797", devoted much of his address to Hutton's unpublished "Principles of Agriculture". He said that to anyone perusing Hutton's immortal "Theory of the Earth", it is clear he pictured his subject as a well-managed agricultural estate with a rotation of processes designed to maintain continuing fertility. One might therefore have expected to find in his agricultural treatise merely a disguised reproduction of his well-known geological tenets. Such is far from the case. Hutton, who spoke to geologists of æons, spoke to farmers of seasons and years. His object was "to make philosophers of husbandmen and husbandmen of philosophers".

The work, if published in its day, would rank among the classics. Its interest is comprehensive. For example, one sentence from a discussion of possible diversification of species by natural selection is remarkable: "Where dogs are to live by the swiftness of their feet and the sharpness of their sight, the form best adapted to that end will be the most certain of remaining, while those forms which are least adapted to this manner of chase will be the first to perish". It must be remembered that this was written by a man who died eleven years before Charles Darwin was born. Similarly, Hutton's account of selection of a pure line of rice, somewhere about the year 1710, by the Emperor Kang-hi, makes it difficult to realize that, when its author died, Patrick Shirreff, famous as pioneer-isolator of profitable strains of wheat and oats, was only six years old.

Hutton's writings on climate and chemistry, physics and metaphysics, are less valuable than his contributions to geology and agriculture; but through them all can be seen the working of a single great idea, a balance of the powers of Nature, which leads to never-ending cyclic continuity. If in one direction Hutton noted destruction, he always found in another direction proof of reconstruction. Thus, in geology, his unaided eyes told him how agents of erosion, under the influence of gravity, were slowly washing the continents down into the sea; while his reason assured him with equal certainty from available evidence that there was internal heat in the earth, which would presently re-elevate the consolidated debris high above the reach of the waves. Among Hutton's other famous contributions to geology may be mentioned the following: granite is an igneous rock, a claim based upon a number of veined contacts; geological processes of the past have been of the same kind and intensity as those of the present; the valley systems of the earth's surface have been sculptured by subaerial erosion operating through millions of years.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, November 24

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Industrial Applications of Inductor Alternators" (to be opened by Dr. J. H. Walker).

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (in the Reynolds Hall, College of Technology, Manchester), at 5.30 p.m.—Dr. Metcalfe Brown: "Smoke Abatement" (Clayton Memorial Lecture).*

Tuesday, November 25

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Colonel D. McMillan: "Hearing as an Essential Part of the Telephone Circuit".

ROYAL ANTHROPOLOGICAL INSTITUTE (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. W. L. H. Duckworth: "Some Complexities of Human Structure" (Huxley Memorial Lecture).

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Harold Spencer Jones, F.R.S.: "The Development of Astronomical Instruments from Early to Modern Times". (Further lectures on December 2 and 9.)

INSTITUTION OF CIVIL ENGINEERS (joint meeting with the BRITISH SECTION OF THE SOCIETE DES INGENIEURS DE FRANCE, at Great George Street, London, S.W.1), at 5.30 p.m.—M. A. Coyne: "Latest Developments of Dams and Hydro-electric Power Stations in France".

ILLUMINATING ENGINEERING SOCIETY (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Prof. H. Hartridge, F.R.S.: "Recent Advances in the Physiology of Vision".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, PHYSICAL METHODS GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Third Annual General Meeting; Mr. B. S. Cooper: "Electron Microscopy".

BRITISH ESPERANTIST SCIENTIFIC ASSOCIATION (in the Department of Psychology, University College London, Gower Street, London, W.C.1), at 7 p.m.—Fourth General Meeting.

SOCIETY OF INSTRUMENT TECHNOLOGY (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Mr. D. Edmundson: "Electronic Developments in Instrumentation".

Wednesday, November 26

PHYSICAL SOCIETY, OPTICAL GROUP (at Northampton Polytechnic, St. John Street, London, E.C.1), at 3 p.m.—Scientific Papers. (Members of the Colour Group are invited.)

ROYAL MICROSCOPICAL SOCIETY, TECHNICAL SECTION (in the Hastings Hall, B.M.A. House, Tavistock Square, London, W.C.1), at 5.30 p.m.—Mr. J. V. H. Wredden: "Microscopy of Enamelled Wire".

SOCIETY OF CHEMICAL INDUSTRY, MICROBIOLOGICAL PANEL OF THE FOOD GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.15 p.m.—Papers on "Biological Stability of Processed Fish and Manufactured Fish Products".

MANCHESTER METALLURGICAL SOCIETY (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. E. W. Colbeck: "Some Metallurgical Problems in the Field of Atomic Energy".

SOCIETY FOR VISITING SCIENTISTS (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Dr. F. P. Bowden: "The Initiation of Explosives"; Dr. W. A. Wooster: "Synthetic Mineralogy".

Thursday, November 27

LINNEAN SOCIETY OF LONDON (at the G.-B. Studios, Film House, Wardour Street, London, W.1), at 5 p.m.—Films.

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Annual General Meeting; Prof. E. C. Titchmarsh, F.R.S.: "Analysis for Physicists" (Presidential Address).

ROYAL INSTITUTE OF CHEMISTRY, MANCHESTER AND DISTRICT SECTION (in the Lecture Hall, Albert Hall, Peter Street, Manchester), at 7 p.m.—Dr. D. T. A. Townend: "Fuel and Chemistry" (Fourth Dalton Lecture).

ROYAL PHOTOGRAPHIC SOCIETY, SCIENTIFIC AND TECHNICAL GROUP (at 16 Prince's Gate, London, S.W.7), at 7 p.m.—Symposium on "Pictorialism and the Characteristic Curve" (to be opened by Dr. S. O. Rawling and Mr. G. Scott-Bushe).

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES SECTION (at the Public Library, William Street, Slough), at 7.15 p.m.—Dr. A. H. Lewis: "Some Aspects of Chemistry in relation to Agriculture".

SOCIETY OF DYERS AND COLOURISTS, WEST RIDING SECTION (at the Great Northern Victoria Hotel, Bradford), at 7.15 p.m.—Dr. P. Schulman: "Emulsions—Oil and Water Dispersal Mediums".

Friday, November 28

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Geophysical Discussion on "Electrical and Magnetic Effects of Marine Currents".

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES SECTION (at Isleworth County School, Ridgeway Road, Isleworth), at 7 p.m.—Mr. J. King: "Scientific Problems in Feeding a Modern Army in the Field".

SOCIETY OF DYERS AND COLOURISTS (at the Technical College, Bradford), at 7.15 p.m.—Mr. M. O'C. Horgan: "Infra-red Drying".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. C. F. Powell: "Tracks of Charged Particles in Photographic Emulsions".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN DAIRY CHEMISTRY (Grade III), and an ASSISTANT LECTURER IN AGRICULTURAL CHEMISTRY—The Secretary, North of Scotland College of Agriculture, 41½ Union Street, Aberdeen (November 28).

LECTURER IN THE SCHOOL OF PHYSICS AND APPLIED SCIENCE, to deal principally with telecommunications—The Registrar, College of Technology and Commerce, The Newarke, Leicester (November 29).

LECTURER (with qualifications and experience in mechanical or production engineering and, preferably, a university degree) IN THE ENGINEERING DEPARTMENT of the County Technical College, Wednesbury—The Director of Education (Dept. F.E.), County Education Offices, Stafford (November 29).

LECTURER IN PHYSICS in the Department of Physics Applied to Medicine—The Secretary, Middlesex Hospital Medical School, London, W.1 (November 29).

ASSISTANT IN THE DEPARTMENT OF NATURAL HISTORY—The Secretary, The University, Aberdeen (November 30).

LECTURER (temporary) IN ZOOLOGY at Auckland University College, Auckland, New Zealand—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (December 1).

LECTURER IN APPLIED MATHEMATICS in the University of Cape Town—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (December 1).

ESTABLISHED ASSISTANT KEEPER (male) at the Botanic Gardens, Glasnevin, Dublin—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (December 5).

CONTROL CHEMIST and an ENTOMOLOGIST, a SENIOR CONTROL CHEMIST and a SENIOR ENTOMOLOGIST, in a survey team investigating pest infestation in Nigeria—The Under-Secretary of State, Research Department, Colonial Office, Palace Chambers, Bridge Street, London, S.W.1 (December 6).

LECTURER IN PHYSICS—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (December 6).

LECTURER IN SOCIAL PSYCHOLOGY—The Registrar, The University, Leeds 2 (December 6).

LECTURER IN THE DEPARTMENT OF CIVIL ENGINEERING—The Registrar, The University, Sheffield (December 8).

ASSISTANT LECTURER IN PHYSICS—The Secretary, University College London, Gower Street, London, W.C.1 (December 10).

LECTURER IN TEXTILE ENGINEERING in the Department of Textile Industries—The Registrar, The University, Leeds (December 10).

ASSISTANT DIRECTOR IN THE DIRECTORATE OF TELECOMMUNICATIONS, and DIVISIONAL TELECOMMUNICATIONS OFFICERS (2), in the Northern and South-western Divisions—The Ministry of Civil Aviation, Establishment Division (B), 10 Fleet Street, London, E.C.4, quoting C.A.Est./1068 (December 11).

RESEARCH ASSISTANT IN BEEKEEPING—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow C.2 (December 12).

PROFESSOR OF APPLIED MATHEMATICS specialized in mathematical statistics or mathematical physics, in the Faculty of Science, Farouk I University, Alexandria—The Director, Egyptian Education Bureau, 4 Chesterfield Gardens, London, W.1 (December 12).

LECTURER IN THE DEPARTMENT OF CHEMISTRY in the United College, St. Andrews—The Secretary, The University, St. Andrews (December 13).

ASSISTANT CHEMIST IN THE PLANT PROTECTIVE CHEMISTRY SECTION—The Secretary, East Malling Research Station, East Malling, Maidstone, Kent (December 15).

DEMONSTRATOR IN PHARMACOLOGY—The Registrar, The University, Leeds 2 (December 15).

DIRECTOR OF SAFETY IN MINES RESEARCH under the Ministry of Fuel and Power—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2044 (December 19).

PRINCIPAL SCIENTIFIC OFFICER, a SENIOR SCIENTIFIC OFFICER, and SCIENTIFIC or EXPERIMENTAL OFFICERS (2), in the Department of Physiology—The Secretary, Rowett Research Institute, Buckburn, Aberdeenshire (December 20).

SENIOR PRINCIPAL SCIENTIFIC OFFICER (Physicist) on the staff of the Joint Fire Research Organization of the Department of Scientific and Industrial Research and Fire Officers' Committee—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2050 (December 30).

SIR WILLIAM H. COLLINS PROFESSORSHIP OF HUMAN AND COMPARATIVE PATHOLOGY—The Secretary, Royal College of Surgeons, Lincoln's Inn Fields, London, W.C.2 (December 31).

PROFESSOR AND HEAD OF THE PHYSICS DEPARTMENT of the Indian Institute of Science, Malleswaram, Bangalore—The High Commissioner for India, India House, Aldwych, London, W.C.2 (Bangalore, December 31).

PRINCIPAL SCIENTIFIC OFFICER or SENIOR SCIENTIFIC OFFICER to investigate the chemical nature and fate during digestion of the different constituents of 'crude fibre' and of 'nitrogen-free extractives' of coarse fodders—The Secretary, Rowett Research Institute, Buckburn, Aberdeenshire (January 1).

DIRECTOR OF MUSEUMS, Museums Department, Malaya—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1.

DEMONSTRATOR IN THE DEPARTMENT OF BACTERIOLOGY AND IMMUNOLOGY—The Assistant Dean, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1.

HEAD OF THE SCIENTIFIC DIVISION—The Director of Research, British Boot, Shoe and Allied Trades Research Association, Satra House, Rockingham Road, Kettering, Northants.

PROFESSOR OF PHYSIOLOGY—Rev. Father A. L. M. Danis, Faculty of Medicine, University of Ottawa, Ottawa, Canada.

PROFESSOR OF CIVIL ENGINEERING, and a PROFESSOR OF MECHANICAL ENGINEERING, at Maclagan Engineering College, Lahore—The High Commissioner for Pakistan, 15–16 Fitzhardinge Street, London, W.1.